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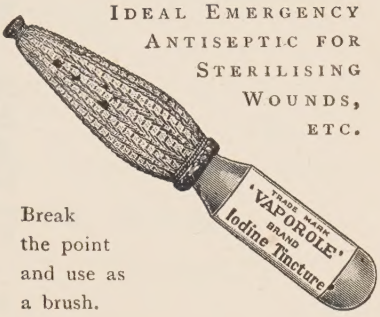

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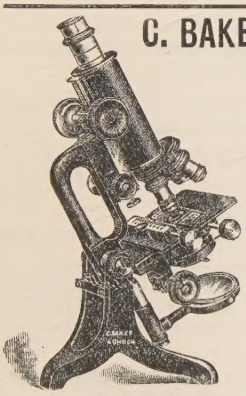

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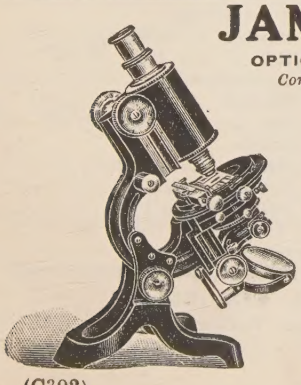

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TROPICAL DISEASES BUREAU.

TROPICAL DISEASES BULLETIN.

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APPLIED HYGIENE IN THE TROPICS.

By Colonel W. G. King, C.I.E., I.M.S. (Retired).

REPORTS.

The Industrial School, Onderneeming, British Guiana.

Reformatory or Industrial schools are factors in the sanitation of communities of no mean importance, and should afford a large scope for study of Eugenics.

In a Report on a school of this character (Onderneeming) to the Government of British Guiana the Superintendent, Mr. G. H. Bayley, gives interesting information as to financial management, and shows how in attempting to improve the moral and physical condition of the young criminal, it is also possible to utilize his labour for the benefit of the State. In regard to the latter aspect of the matter, it would be inappropriate in this *Bulletin* to do more than indicate that, with the labour at disposal, the Superintendent has been able to conduct numerous experiments with plant growth and animal stock breeding, of economic importance in British Guiana. As to general health, Mr. Bayley reports that this "can only be described as fair, the daily average of sick having been 5·6 per cent." But he adds the following complimentary allusion to the Medical Officer in charge :—

"The average percentage sick during the months April to July was 9·5 as compared with 2·4 during the closing months August to December. This improvement is, I think, to a large extent attributable to the skill, care and attention which Dr. Sholto Douglas has devoted to the institution since his assumption of duty as Medical Officer in August."*

Tables are given for ten years showing, at ages, the mean rates of annual increase in height as well as weight. Unfortunately, these heights and weights are not identified with races, but are the product

* Report on the Onderneeming Industrial School (British Guiana) for the Nine Months, April to December, 1915. 1916. Georgetown: "The Argosy" Company Ltd.

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of measurement of a mixed population which, in 1915, was as follows — Black Creoles, 74·8 ; East Indians [natives of India), 11·81 ; Portuguese, 3·15 ; mixed races, 9·45 ; Aboriginals, 0·79 p.c. Nevertheless, the figures, as follows, may be of utility in making comparisons with other known results :—

Age.	Height. Mean Rate of Annual Increase. Inches.	Weight. Mean Rate of Annual Increase. lbs.
10	1·6	5·7
11	1·8	6·1
12	1·9	7·1
13	1·9	8·6
14	1·9	9·3
15	1·9	10·1
16	1·6	10·1

No statement is furnished of the diet of the boys in this school, and it may well be that, granting it was liberal in total constituents, no inimical influence is likely to be noted in future ; but, if the balance was likely to be upset easily, the following statement may be of future interest as to this school :—" In the interests of economy, corn bread has been substituted for wheat bread in the inmates' diet."

As to physical fitness the following statement is made :—

" The work of the boys on the whole has been very satisfactory. Comparisons with free labourers which are often made, prove that the bigger boys who are exempt from further school work, and labour in the fields eight hours per day are easily able to perform in that time as large a task as the average free labourer gets through in one day."

Fiji.

Dr. H. Macdonald, Rotuma, Fiji, in his Report* gives a condensed account of useful sanitary work performed by him as a District Medical Officer :—

" *General Sanitary Work.*—A good deal of sanitary work was done, the details of which are noted in the Medical Officer of Health's journal here and will be given more or less in my report as Medical Officer of Health. All villages have been visited during the year, and their sanitary condition noted. Latrines, water tanks, kitchens, houses, cemeteries have been visited, punts and boats inspected, schools and dormitories measured and the attention of those in charge of them drawn to deficiencies in cubic space where such deficiencies existed. Advice has been given to the phthisical as to sputa and an endeavour has been made to isolate them as far as possible. All lepers have been removed to Makogai during the year and the bush-huts they resided in burnt. At the close of the year all concrete houses —the majority of the houses here are concrete—were white-washed inside and out, and all water tanks were scrubbed out. Bye-laws regarding privies and the prevention of the breeding of mosquitoes were framed and passed and are now in force. Bye-laws regarding dwelling-houses were also framed and sent in for approval."

*Annual Medical Report, 1914, Council Paper No. 23, pp. 14–15.

DISEASE PREVENTION.

Malaria.

The Anti-Malarial Zone.

It has always seemed to the writer that one of the most practical results which should follow mosquito-work by Ross would be a definite statement as to what distance from a source of malaria habitations might be placed, or, in terms adapted to the present etiological requirements, as to what is the flight of anophelines; for, *upon the answer to this query, depends the practicability of most anti-malarial measures and their cost.* Considering the number of years that has elapsed since the mosquito was convicted of being the malaria bearer, and the amount of refined entomological work fulfilled as to this particular insect, it is extraordinary how little attention has been given to this eminently practical point. There were certainly difficulties in the way. It is not always easy to determine that mosquitoes have no rendezvous beyond the pools known and under treatment. Strenuous search may detect in an apparently dry and scorchingly hot sandy waste, by some freak of subsoil formation, a mere basin full of water with that gentle renewal of clean contents under pressure that is the special delight of the prolific anopheles; and, hence, calculations of distances between the nearest possible pool and habitations have been liable to error.

Celli ("Malaria," by Angelo Celli, 1900, p. 246) in the light of possible mosquito flight, held that a protective zone from the influence of irrigation should be from 2 to 3 kilometres. He also quoted statistics showing that the apparent influence of rice fields extended to an extreme of from 4,000 to 5,000 metres, and that in a radius of 300 to 400 metres the danger was imminent.

With the knowledge of ancient Italian legislation efforts, and aided by a clear history of introduction of malaria fever following excess water for irrigation, in the formerly healthy locality of the head quarters of the Kurnool District, the writer secured in 1881 a protective zone of *one mile radius* for that town. Considering the absence of removal of complete facilities for mosquito-breeding (then of course unknown) the results were excellent. In adapting the one mile standard, the writer depended on the evidence of Dempster (of splenic index fame) when on a committee regarding the limitation of irrigation in the Peshawar Cantonment. His opinion, with that of his medical co-signatories, was embodied in a note, which is well worth repeating in the light of the modern etiology of the disease:—

"The distance which secures safety from the effects of malaria varies according to certain circumstances, some of which can only be accurately ascertained after considerable experience. With such a stiff clayey soil and with such facility of swamping as the land which exists in the neighbourhood of Peshawar, we consider two miles a prudent distance, but one mile at least is in our opinion essential to safety under such conditions as there present themselves; unless when any part of the City may intervene * between the malarious locality and the ground occupied by the troops. According to almost universal experience, there is no more ready way of generating malaria in such a climate as this than by profusely irrigating a

* See note *re* Malaria, p. 353, Vol. 3, of this *Bulletin* (Sanitation Number) 1914. April 30.

stiff retentive soil, and, therefore, we believe it imperative not only to *prohibit all Canal irrigation within one mile of the Cantonment pillars, but to take steps for securing the perfect drainage of the space included within this line.*"* [Italics not in original.]

In 1888, the writer secured for the inhabitants of a hamlet (situated on land irrigated to the doors of the huts) practically decimated by malaria, a new elevated well drained site, free from jungle for a mile, with a protective zone of only 250 yards from irrigation. The zone was of necessity a compromise, and it was feared complete protection might not be secured; the result was however excellent. In 1908, STEPHENS and CHRISTOPHERS ("Practical Study of Malaria," p. 183), stated:—"In the case of the above species [*Mym. culicifacies*, *Nyss. Stephensi*, and *Nyss. fuliginosus*] they undoubtedly fly fairly readily a quarter of a mile, but half a mile appears to be beyond the normal distance of flight."

In 1909, Major GOOD, I.M.S., reported officially to the writer, on good grounds, the three-quarter mile flight of anopheles from the only available pool at Magok, Burma. In the *British Medical Journal* (1913, May 24, p. 1136) Captain T. C. MCCOMBIE YOUNG, I.M.S., shows that after the treating by kerosene of possible pools, invasion by mosquitoes occurred from 1½ miles distance "on a gentle breeze." SHIPLEY, in the *British Medical Journal* (1915, January 16, p. 106) also discusses this important matter.

Malcolm WATSON (p. 65 "The Prevention of Malaria in the Federated Malay States") has afforded excellent evidence to show that the grade of safety increases, according as the distance from sources of mosquito propagation increases. He found that whilst within 300 yards of *undrained* jungle the spleen rate was 47 per cent., at 1,000 yards it diminished to 2·6 per cent. Major FRY, I.M.S., found at the edge of undrained jungle the spleen rate was 59 per cent. but, at 200 yards distance from it, there was a decline to 23 per cent. and, at one mile from it, the spleen rate was *nil*.

Such data tend to secure definite ideas, but it has remained for the sanitarians of the Panama Canal to give opinions on the subject founded upon more direct evidence. Mr. ZETEK, one of the subordinates of Mr. Le PRINCE (the Chief Sanitary Inspector) evolved a method of staining captured anopheles with aniline dyes, by use of a fine spray. Special arrangements were made for their recapture, after allowing freedom for flight. Twenty-four so treated were found at from 4,000 to 5,000 feet, and five at 6,250 feet distant from the site of their release. Of the latter, four were *Anopheles tarsimaculata* and one *Anopheles albimanus*. Summing up his experience generally Mr. Le PRINCE holds that these chief malaria bearers at the Panama Canal, where their breeding was prolific, were able "to travel from a half-mile to one mile to reach houses."

The following are quotations from "Sanitation in Panama," by Surgeon-General GORGAS, which give a fair idea of the value of distances as ascertained in practice:—

"The Zone extends for five miles on each side of the Canal, that is, a strip ten miles broad and fifty miles long. Most of the population was

*Note by the Medical Members of the Committee on the necessity of prohibiting canal irrigation within certain limits of the site of the new cantonment [about 1863].

located on each side of the Canal, within about a mile of its axis, while few houses and cabins were scattered through all parts of the Canal Zone.

"Sanitary work, generally speaking, was done only within a mile or so of the Canal itself. All brush and undergrowth were cleared within two hundred yards of houses and villages, and the ground carefully drained within the same area. There was no object in carrying sanitary work beyond the populated area. Even if mosquitoes bred where no human beings were living, no harm would be done, as there would be no one to infect. . . .

"Against malaria he [Sanitary Inspector] had a sufficient number of labourers under one or more foremen, according to the size of the district, who cut the brush and undergrowth within two hundred yards of all villages, houses and dwellings, and who also cut the grass within this area whenever it reached a foot in height. . . .

"The anopheles, the malarial mosquito, is not a mosquito of strong flight; two hundred yards is in general, a good long flight for her. If there were trees and shrubs and bushes every few yards, the anopheles mosquito might travel very long distances and not be much exposed to either the sun or the wind. But if an area of two hundred yards around each building is kept clear, she will not often be able to cross such a zone without destruction, either by sun or wind. . . .

"The drainage was, of course, very much more extensive in area than the grass and bush cutting, for not only had the cleared zone itself to be drained, but all the area within that zone, and also the water-courses leading off from the drained areas had to receive attention. Many times we found that anopheles were breeding very much beyond the two-hundred-yard limit and still coming into the village. In one case we had a very large flight of anopheles which lasted for two or three weeks, and they were found to be breeding more than a mile from the village of Gatun. So, as a matter of fact, our work was very many times carried beyond the two-hundred-yard zone."

At page 23 of the Annual Report of the United States Public Health Service for 1915, it is stated in describing anti-malarial methods:—"The work should extend, for practical purposes, a quarter of a mile or more beyond the corporate limits or bordering residences to be benefitted."

Anti-Malarial Measures in India.

The fact that the Agricultural Department of India is now urging the importance of soil drainage as an agricultural measure will, in the near future, secure for that country more adherents to that method as an anti-malarial measure than in recent years. In the absence of knowledge of the connection of the mosquito with the etiology of malaria, doubtless efforts made in the past were incomplete—but they were by no means devoid of influence. Hence, at the present time, as it would seem to be forgotten that India can supply illustrations of utilization of drainage as an anti-malarial measure, the following extract from a Report by Surgeon Captain Dyson, I.M.S., in 1892, when Deputy Sanitary Commissioner, Punjab, is of interest:—

"Previous to the year 1868, reports were rife that the villages irrigated by the Western Jumna Canal were being severely water-logged, and that, in consequence, the population was dying out, and the land falling out of cultivation. So grave were these rumours that, in the year 1868, Dr. Adam Taylor, then Civil Surgeon of Delhi, was deputed to inspect certain selected irrigated villages regarding their health. . . . He used the existence of an enlarged spleen as evidence of the ill-health of the people. . . In consequence of his report, large portions of the Western Jumna Canal were re-aligned, and drainage schemes were put in force. In the year 1892, the Punjab Government was anxious to ascertain whether these

measures had effected any material improvement in the condition of the inhabitants of the canal area. In consequence, I was directed by the Government to carry out an enquiry in the same villages as those inspected by Dr. Taylor and on the same lines. . . . . In carrying out these investigations the spleen test was used ; in each village 20 adults and 20 children were examined for the existence of enlarged spleens. In large towns, 50 adults and 50 children were examined in each quarter. . . . The size of the spleen was registered under the following heads :—

1. Very large=extending across the median line.
2. Large=extending to the median line.
3. Medium of the five classes.
4. Considerably enlarged.
5. Slightly enlarged=*i.e.* could be felt under the ribs.

"Dr. Dempster was the first person to select, in the year 1845, the existence of an enlargement of the spleen as the indicator of the amount of malarial disease existing in the locality, and Dr. Taylor and myself also followed his practice. . . . Though the re-alignment of the canal has done much to improve the health of the population yet the system of surface and deep drainage has also greatly contributed to this improvement. The Western Jumna Canal area is now lined with shallow surface drains connecting one village jhil (or pond) with another and ending in deep sub-soil drains. All deep and large village ponds are being drained, so that they only contain sufficient water for the use of the cattle during the hot weather and no more. Large areas of ground which used to be occupied by sheets of water are now dry and brought under cultivation. . . . A typical instance of the great improvement produced by drainage may be noted in the case of Mehmúdpur, in the Rohtak district ; of this village Dr. Taylor writes :—'Take Mehmúdpur, here 52·5 per cent. show an amount of malarial disease, the causes of which can be appreciated at a glance ; a huge swamp filled with alligators and waterfowl runs to the walls of the village, the water in the wells is not a foot below the surface ; great complaints of sickness were made. This village has been thoroughly drained since the swamp has disappeared, and its place is now occupied by crops, and the spleen percentage has dropped from 52·5 to 22·5. . . . I venture to think that there can be little or no doubt that the Western Jumna Canal undoubtedly exerted in former times a most baneful influence on the health of the population. It is, therefore, a matter for congratulation that this evil was recognised, and steps promptly taken to ameliorate the condition of the people. That the remedies applied have exerted a most beneficial effect can be recognised by a glance at the returns showing the results in the examinations of 1868 and 1893. . . .' "

Average percentages of persons found to be suffering from enlargement of spleen in villages inspected by both Dr. Taylor and Dr. Dyson* :—

Area.				Percentages found by Dr. Taylor.	Percentages found by Dr. Dyson.	Increased percentages since 1868.	Diminished percentages since 1868.
Karnál District	A.	Canal village	Re-aligned or drained	45·75	27·25	..	18·50
Delhi do.	B.	do.		50·56	41·11	..	9·45
Karnál do.	C.	do.		35·50	27·86	..	7·64
Karnál do.	D.	do.		37·95	21·82	..	16·13
Delhi & Rohtah & Karnál	E.	do.		34·29	28·64	..	5·65
Delhi & Rohtah	F.	do.		30·28	40·00	9·72	..

*Dr. Dyson examined, in villages grouped A to F, 3,160 and Dr. Taylor 2,880 persons.

Anti-Mosquito Measures.

Progress in Anti-Mosquito Measures, Port of Spain. "The number of deaths from malaria in the city and the rate per 1,000 of population have steadily declined, within the past ten years, from 71 deaths and a rate of 1·25 in 1905–06 to 39 deaths and a rate of 0·61 in 1914–15. A very careful and exhaustive mosquito survey within the City limits and their surroundings was made recently, when some anopheles breeding grounds were brought to light which were promptly dealt with where possible, and suitable measures of correction now in progress were recommended in other cases; it may be asserted with confidence, I think, that Port of Spain itself is free from dangerous anopheles mosquitoes, and that practically all cases of malaria that come under notice there are imported."*

Queensland.—After deprecating diminution of anti-mosquito measures, the Commission for Public Health, Queensland† states :—

"It is now more than ever necessary that the full squad be re-engaged, as malaria may at any time be brought to Queensland by returning members of the military and naval forces garrisoning the Empire's recently acquired colonies, situated in the South Pacific, and where malaria at present exists.

"Moreover, the question of yellow fever . . . . can only be dealt with by active mosquito operations. Now that the Panama Canal has been opened, the danger of this disease gaining admission to this State must not be lost sight of, and it is desirable that the necessary means be placed at the Department's disposal to deal with the question. It is with reluctance, in view of the present disturbed financial conditions of the world, that any increase of expenditure is recommended, but the matter is of such importance that I feel I would be failing in my duty were I to omit bringing it under special notice."

Anopheles in the United States.

The following is an extract from the U.S. Public Health Service Annual Report for 1915 (p. 21) :—"Frederick Knab gives a list of 34 species of American Anopheles, of which number 8 have been definitely shown to serve as hosts for the malarial parasite. These are :—

Anopheles albimanus,	*Anopheles pseudomaculipes,*
,, *argyritarsis,*	,, *pseudopunctipennis,*
,, *crucians,*	,, *quadrimaculatus,*
,, *intermedium,*	,, *tarsimaculata.*

"The most common species encountered in the Southern States where surveys have been made are *Anopheles crucians, quadrimaculatus,* and *punctipennis.* The last named, *Anopheles punctipennis,* is not considered to be a transmitter of malaria. *Anopheles crucians,* according to experiments by Beyer and his co-workers, is said to be a transmitter of the estivo-autumnal parasite only, but this needs confirmation.‡ It is evident from this that Anopheles mosquitoes may be present and yet no malaria prevail, and again, the prevailing species may determine the type of malaria. *Anopheles quadrimaculatus* will transmit all three types of malarial parasites, and this species is the one most commonly found in the Southern States where malaria prevails."

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*Trinidad and Tobago. Report of the Surgeon-General for 1914–15. p. 11.

†Queensland. Annual Report of the Commissioner for Public Health, to June 30, 1915. p. 8.

‡Recent experiments by MITZMAIN show that this species is infectible with the parasites of benign tertian malaria [this *Bulletin,* Vol. 8, p. 40]. The same worker and N. V. KING have shown that *A. punctipennis* transmits benign tertian in New Orleans [*loc. cit.*].

Trees and Mosquitoes.

In pre-Ross days, the use of a belt of trees as an anti-malarial measure had many advocates. There was however no unanimity of opinion in the matter as to efficacy. By those who found the method of utility, the screen prevented the penetration of air-borne malaria from distant points, and by dealing with excess moisture of soil locally prevented the successful propagation of the malarial germ. The latter was in later years the more usually received theory and, in consequence, trees that required abundance of water for vigorous growth were diligently sought for. Thus by no means undeservedly the Eucalyptus attained fame. The tree however has its limits of endurance in the tropics, and cannot be expected to flourish beyond the cooler heights of hill ranges.

In knowledge of mosquito habits in the present day, the position of trees in the malaria question requires modification. Not only do they afford shelter in the presence of sun-glare for *franc tireur* mosquitoes bred in the neighbourhood, but hollows capable of retaining quantities of water sufficing for their breeding. The following is an extract from the Report of the Department of Health of the Panama Canal for April, 1916, on the subject :—

"During the month the work of cementing tree cavities was undertaken, as this has been recognised as an important antimosquito measure, but had not been undertaken before in Panama City.

"In the City, 1,611 trees were treated, plugging such cavities as might become 'containers' on account of holding water. A cement and sand mixture of 1–4 was used to close the cavities. Where large holes were found pieces of rock were used to fill in, reducing amount of cement needed. Count was kept on about 1,000 trees to determine the number of cavities per tree which during the rainy season would act as water containers with consequent mosquito breeding. An average of 2·55 holes per tree was found, and using this figure for total number of trees treated, we find that 4,108 possible containers were eliminated. The large trees presented the greater number of cavities, naturally, and decayed places where limbs had been broken off, and in the angles formed by branching were to be found the most frequent sites. As many as 22 cavities were found in one tree requiring filling.

"It is interesting to report that quite a number of the cavities found, even at this season of very little rain, contained mosquito larvae, and larvae from several of these were identified later as stegomyia. Stegomyia were only found, however, in trees quite close to houses."

Whilst thus affording shelter and breeding facilities for the mosquito, it would be a mistake to arrive at any axiomatic ruling as to the presence of trees. Each case must be judged by the completeness or otherwise of removal of mosquitoes, and their flight distance from suitable water facilities for breeding. But it is well to remember that the old theory as to removal of excess moisture from the soil is sound. Not only is the transpiration of moisture by trees a factor to be reckoned upon, but the influence of their roots upon neighbouring soil is of direct advantage in securing permeability, and therefore relief of surface drainage. In certain areas, these influences must be of further utility for the same reason in preventing scouring of hollows for pool formation, and in delaying the yielding by the upper layer of soil of moisture to the subsoil flow, and the consequent restraint of sudden heightening of subsoil water—to the peril of water-logging of areas in low levels.

Fish as Larvicides.

The following quotation from p. 15 of the Annual Medical and Sanitary Report, Gambia, 1915, exhibits at once the advantage of "jungle clearing" in exposing otherwise unrecognizable pools, as well as the adaptability of certain species of fish to either brackish or salt water. Unfortunately, the Report gives no indication of the particular fishes employed.

"Clearance of undergrowth has been extensively carried out round the town and in the Old Cemetery. The latter clearing revealed the fact that there were three fresh water lagoons at the western extremity of the cemetery near to the seashore which were swarming with larvae of *Culex*. It was known that at certain periods, and when the wind was in the west or north-west, frequently great swarms of mosquitoes invaded the town, so that it was not unusual to be able to capture fifty to a hundred specimens of *Culex* from one ordinary sized window of mosquito gauze within two or three minutes. The cemetery was suspected of being the culprit and a close inspection revealed the above condition.

"The difficulty arose how to treat these comparatively large expanses of water and it was decided to fish-stock the two largest, about a dozen buckets of small fish obtained from the drains being carefully placed in them. The results were most satisfactory; the fish increased in number and the larvae disappeared entirely. . . .

"The large salt water lagoon in which *Culex thalassius* breeds, referred to on page 14 of the Annual Medical Report for 1914, was stocked with some forty buckets of fish taken from the same drains as the above, with equally satisfactory results. It is of interest to note that these fish appear to be able to acclimatize themselves to either brackish or salt water, and they are of untold value to Bathurst, since they can be obtained for nothing and are voracious eaters of larvae. Constant care is, however, necessary to keep up the stock in the lagoons owing to wastage from predatory birds, such as egrets and kingfishers. Pits dug in the bottom of the pools afford some shelter to the fish."

Larvicide Ducks v. Fishes.

In experiments conducted as part of the anti-malarial operations in the City of Madras, for the quarter ending the 31st March, ducks were given a fair trial as larvicides. It is reported (Madras Government Order No. 1131 M., dated 1st July 1916) that a

"pond was completely cleared of weeds. Ducks were let in for the whole of the day time. They exercised no influence upon the life of the mosquito larvae. This was tried on three occasions at intervals of about three weeks; on each and all the three times no satisfactory results were obtained. . . . The pond in the compound of Branson's bungalow was free from fish, and it was considered a suitable place for putting in ducks. This was done, and the pond was examined every third or fourth day. The mosquito larvae continued to thrive as well as before. This was continued for four weeks and, as no satisfactory results were obtained, the experiments were stopped."

In the same Report, it is stated that a re-survey of 2,247 wells which had been stocked with larvicidal fish was conducted. In only 322 wells, or 14·3 per cent., larvae were found. Fish were found dead in 258 wells or 11·14 per cent.

Mosquito Screening.

The following somewhat indefinite but hopeful description of a new contrivance is given at p. 22 of the Annual Medical and Sanitary Report

for the Colony of the Gambia for 1915 :—" A new form of mosquito protection of tanks has been devised, which entirely avoids the use of gauze at the inlet and outlet of water. It is hoped that this may be adopted experimentally to certain of the tanks before the onset of the next rains."

Yellow Fever.

The following is the forecast (p. 13, Medical and Sanitary Report, Gambia, 1915) of possibilities at Bathurst in respect to yellow fever :—

" A total of 622 specimens were taken and examined with, roughly, the following percentages :—

Stegomyia	94 per cent.
Culex	5·5 ,,
Anopheles	0·5 ,,

" In view of what is stated on page 15 (' Bush Clearing ') the low percentage of *Culex* breeding in the town is somewhat notable, but the extremely high *Stegomyia* percentage points to the absolute necessity of making a determined campaign against the conditions of mosquito breeding in compounds. Although a commencement has been made towards the extermination of the mosquito in Bathurst, and a certain reduction already effected, the existing state of affairs is only too favourable to the spread of yellow fever if it should gain ground in Bathurst, so no relaxation of our efforts can be permitted."

In this connection, it is worthy of note that at p. 21 of the Report under reference, it is stated that Stegomyia are not found in McCarthy Island.

Dysentery.

Egypt.—For a considerable period, the profession has recorded the fact that dysenteries are of bacillary and amoebic types with a certain amount of apathy as to sanitary measures ; the tendency has been rather to study treatment of these diseases than to investigate the subject of their prevention. The results as to treatment have been brilliant, but as to sanitation practically *nil.* The facts illustrate the writer's contention that whilst laboratories for clinical and pathological work and those engaged in research for preventive medicine should be in free intercourse, their *personnel* and administrative control should be distinct (*vide* this *Bulletin* (Sanitation Number) 1915. June, p. 468).

The occurrence of dysenteries as one of the causes of disablement in the more eastern area of the present war, has doubtless stimulated investigation. Thus, it is found that Sir Ronald Ross, when on service in Egypt, in collaboration with Captain D. Thomson, R.A.M.C.,* undertook an enquiry as to the duration of vitality of the *Entamoeba histolytica.*

Dysenteric stools were deposited in the ordinary dry sun-baked Egyptian sand in covered trays. The deposits were microscopically examined daily, with the result that whilst, by the third day, in no form was the *histolytica* recognizable, there were present swarms of amoebae and flagellates which were of the same class but, so far, were found to be non-pathogenic ; nevertheless, it was thus ascertained that " protozoa of the same class did exist in the sand which

*Proc. Roy. Soc. Med., 1916. Jan. Vol. 9. No. 3 (Sect. of Epidemiol. and State Med.). pp. 33–48.

was dry during the greater part of the year." On Sir Ronald Ross's return to England, further investigation was conducted by Captain David THOMSON, R.A.M.C., and Lieut. Gordon THOMSON, R.A.M.C. In an interesting paper in the *Journal of the Royal Army Medical Corps* of July, 1916, they state, in detail, the results of numerous experiments of a laborious nature. They used the *Amoeba limax* as sufficiently typical of the *Entamoeba histolytica*, but they assert: "We have been careful not to assume because the cysts of free living protozoa are very resistant to external conditions, the pathogenic species must have similar powers. It is likely that the cysts of the latter are more delicate." This work with the amoebae must prove of much future importance, but their remarks conveyed in the June number of the same Journal as to the vitality of *E. histolytica* are of present practical importance.

They hold (*Journal of the Royal Army Medical Corps*, 1916, June, p. 692) that infection "undoubtedly takes place by means of cysts, which in some way are conveyed to the mouth and swallowed." They have conducted successful feeding experiments of kittens illustrating the fact. They point to accidental contamination of the food of man by his hands, or by flies; and call attention to the fact that faeces passed in the neighbourhood of a camp in sandy areas are soon intimately mingled with sand, and particles are thus liable to be blown long distances.

It is as the bearer of cysts, therefore, that a dysenteric patient is liable to become a dangerous "carrier." The authors show that treatment by emetine short of sufficient to kill *E. histolytica* expedites the formation of cysts and, consequently, this is a point of the greatest importance in the treatment of dysentery, and, the writer would add, both from a medical and sanitary point of view. To this end, they lay down the rule that "never less than twelve grains of emetine should be given in a continuous treatment of one grain daily."

The importance of the cyst stage is further emphasized by the authors pointing out that it has been proved by many observers that the cysts are infectious when swallowed, whilst Colonel WENYON has shown that the mobile stage of the pathogenic amoeba is not infectious by mouth. Indeed, "the cystic phase is the sole cause of transmission," and these cysts are able, under favourable circumstances, *to live for at least a month outside the body.*

Not without good cause, as the authors show, is there reason to regard the fly (with the most scanty opportunity of settling upon specifically contaminated faecal matter) as a great factor in spread, but they do not follow the tendency of the day to forget the rôle of water. They state, "with regard to water we have already shown that the cysts can live in it for several weeks, so that drinking water contaminated with faecal sand is a source of infection."

Malaya.—The observers in Egypt are not alone in grasping the importance of further investigation of the dysenteries. Under the Director, Dr. Henry FRASER, the subject has received attention in the Kuala Lumpur Laboratory. The stools of one hundred and twenty-three cases of dysentery were examined. Of these, 44 were amoebic, 67 were non-amoebic, and twelve were not considered to be dysenteric.

The non-amoebic, or bacillary, cases proved specially difficult of study. Dr. Fraser states that, "even after months of practice

dysentery bacilli could only be isolated from about half the cases of non-amoebic dysentery." The conclusion was arrived at that the "dysentery bacillus of Flexner, the bacillus "Y" of Hiss and Russell, and Strong's bacillus are not distinct types." It is advised that these names be abolished. Dr. Fraser holds that, in Malaya, there are two types of bacillary dysentery; the less common is that caused by Shiga's bacillus, the more common is caused by a mannite fermenting bacillus unnamed.

He regards the use of vaccines as likely to give the best results in bacillary dysentery. "By a series of experiments on animals, it was found that strains of these bacilli which had been treated with specific serum were not harmful in quantities which of the untreated bacilli were harmful." He obtained serum from rabbits, which became potent in a month. He gives a description of his method of making the vaccine (p. 42) by adding a serum specific for the organism to a killed culture, the mixture being then incubated for one hour. He shows that it has well justified his expectation. He then adds, "It is probable that, apart from its value as a curative agent, the treatment will confer a higher degree of immunity than that which may be derived from an unaided recovery, and that the tendency to relapses, or recurrences, will be lessened."

Sierra Leone.—Dr. Burrows, Acting Principal Medical Officer, in his Report for 1915, states that one of the outstanding features of the past year was the unsatisfactory condition of health in the jail of Freetown.

Dysentery and diarrhoea prevailed to an undesirable extent; on an average strength of 258 prisoners, there were 63 admissions under the former, and 41 under the latter head. From all causes, the total deaths were at the very heavy rate of 108·5 per mille. The Medical Officer in charge of the jail states:—

"The Sanitary condition of the prison is good. The yard has been macadamized and a new drain which bears off all surplus water during the rains. A new cooking apparatus has been ordered, and a suggestion that the new enlarged kitchen should be made fly proof has been approved."

A Medical Committee which considered the subject of ill-health held that the sanitary condition left nothing to be desired, that the food was abundant, varied and well cooked, but advised an addition of limes and tomatoes. As to water supply, they concluded, "as all drinking water is boiled there can be little or no risk of infection from this source.

The dysentery was in the majority of cases of amoebic type. The precautions taken of boiling the water and the future fly-proofing of the kitchen are obviously in the required direction, and the results should be of sanitary interest. In the meantime, the following remarks by the Senior Sanitary Officer must be held in mind:—

"It was understood that an outbreak of dysentery amongst the prisoners at the new gaol was attributed to the water supply, but the question of remedial measures was not referred to the Sanitary Department. The fact that there have been within the catchment areas amongst other squatters, charcoal burners, woodcutters, farmers, a new military road and watchman's dwelling have added to the difficulties of the subject."

An estimate of the future position is therefore incomplete, in the absence of information as to protection of water at its source, as to the actual amount of water boiled per day, its method of distribution and

protection from contamination, possibility of access to other sources by prisoners during the course of labour, precautions taken as to segregation and destruction of dysenteric stools, and as to possible amoebic bearers, etc.

In thus regarding various factors which may qualify conclusions, it would seem from a statement made by Dr. JARRETT as to conditions in 1914 that the boiling of water need not *per se* have secured safety (p. 20, Annual Report of the Medical Department, Sierra Leone, 1914) :—

" *General Health.*—There was an outbreak of dysentery during the June quarter, which was said to have been brought on by contamination of the water supplied for drinking purposes. Steps were taken soon after the outbreak to have this remedied by having the water boiled, which has been done ever since. The outbreak ceased during the rains, and there were no fresh cases up to the end of the year."

Fiji.—Dysentery forms an important factor in mortality in Fiji. The following is an extract (p. 3) from the Annual Medical Report for 1914 by Dr. A. MONTAGUE, Acting Chief Medical Officer :—

" Dysentery as usual accounted for more deaths throughout the Colony than any other single disease ; 41 per cent. of all deaths at the provincial hospitals, 17·07 per cent. at the Colonial Hospital and 8·87 per cent. at plantation hospitals being due to this disease. Of 564 deaths occurring in the practice of Medical Officers and native medical practitioners, 149 were due to dysentery. A large number of cases and deaths also occur among Indians, not indentured, and Fijians who are not attended by any qualified medical practitioner. The number of cases of dysentery treated during the year was 110 more than 1913. . . .

" The year was a relatively satisfactory one as regards dysentery, although the number of cases attended was higher than in 1913. The mortality rate was lower except among those treated by native medical practitioners. There are several small epidemics in native towns, particularly on the Rewa River and its upper tributaries, but also in Bau, at Gau in Lomaiviti, at Vatulele in Nadroga, and at Ba. Comparatively few cases originated in Suva, or Levuka. The number at plantation hospitals shows a decrease."

Dysentery and Quinine.

In the Report of the Teck Seng Hospital, embodied in the Straits Settlement Report for 1914 (p. 117), the following remark occurs in a discussion of the influence of the administration of emetine :—" In some thirteen cases, malarial parasites were demonstrated in the blood ; whether an individual so infected loses his power of resistance to an invasion by the specific amoeba or bacillus of dysentery is a doubtful point, though one might suppose that the resulting anaemia would render him more susceptible to infection." This is, of course, a legitimate speculation, and is of the nature which incites to research. It might well be extended by citing the obviously congested condition of the liver, spleen and intestine during attacks, and the influence of repetition of such conditions interfering with the physiological function of the digestive and blood elaborating apparatus. That there is probably increased susceptibility of a malaria stricken population to various forms of intestinal derangements, few would feel inclined to deny. If a population amongst which both malaria and dysentery have prevailed has, by special attention to anti-malarial measures, shown sudden and marked improvement as to prevalence of dysentery, the fact should be of some value in showing some connection between the diseases, if anti-dysenteric methods remained unaltered, or amenability to similar methods of repression.

The following extract from an Official Note by the writer (Information supplied for the Simla Anti-Malarial Conference of 1909) shows that the late Lt.-Colonel FRENCHMAN, C.I.E., then Inspector-General of Prisons, Burma, was so struck with the influence of quinine on dysentery that the first use of quinine prophylaxis in that province was due to that observation :—

" Valuable evidence on the use of quinine as a prophylactic is forthcoming from information kindly supplied by Lieutenant-Colonel Frenchman, I.M.S., Inspector-General of Prisons, Burma, showing that the method has been in systematic use in the jails of Burma. In 1903, an experiment was made with reference to influence on dysentery in the Myaungmya Jail. Results were so satisfactory that in 1904, the method was extended to six more selected jails. Hitherto, 10 grains per week in a single dose had been employed. By April, 1905, the systematic issue of two 10-grain doses of quinine every week as a prophylactic in cases of dysentery due to malarial taint, was directed in all jails. Feeling more confidence as the results were systematically tabulated and scrutinized, Lieutenant-Colonel Frenchman, in January 1906, further extended its use to all jails in Burma. In the circular on this subject, he required all Superintendents to interrogate and examine every new admission into the jail with the object of ascertaining whether quinine should be administered or not. It was required, in cases where it was necessary to administer quinine, that the treatment should commence at once, and not be postponed till the prisoner was admitted to the hospital. The result was the formation in each jail of a ' quinine-gang,' the members of which were kept systematically under two 10-grain doses per week, until the Superintendent was satisfied that all danger of relapse had passed. These principles have been definitely embodied in the Burma Jail Manual, section 982. I attach a summary of results (G and H) on the health of prisoners as supplied by Lieutenant-Colonel Frenchman, showing the admission and death-rates before 1903 and subsequently. My inspection, as an official visitor of jails, has shown me that not only the prophylactic use of quinine is relied upon, but also that each Superintendent carefully observed all mosquito brigade methods. In the majority of cases, the diagnosis of malarial fever is verified by the microscope. It would be idle to say that ordinary sanitary precautions in jails have not also contributed to the total result upon the health of prisoners between 1903 and 1908, but, within this proviso, it is evident the system of prophylaxis has been highly successful. Thus, if the combined admissions and deaths under malaria and simple continued fever in the ante-quinine period be considered, it will be found that the admission rate was 145·40 and the death-rate ·62 per mille of average strength, whilst in the post-quinine period, the admission rate declined to 65·30 and the death-rate to ·53 per mille of average strength. The influence is also very marked on the admission and death-rates for dysentery and diarrhoea, pneumonia, anaemia and debility. Practically, an influence has been exhibited on " all causes ;" so that whilst in the ante-quinine period, the admission-rate under this head per mille of average strength was 538·52 and the death-rate 17·28, in the post-quinine period, the rates declined to 297·64 and 14·87, respectively."

In perusing the original statistics the fall of the dysentery rate seemed to the writer so direct, as to suggest as a legitimate speculation that quinine has an inimical influence upon one or both forms of dysentery. The point would at least seem worthy of research.

Dysentery and Contaminated Clothing.

A preceding note dealing with the vitality of the *Entamoeba histolytica* shows that, in the cyst form, it can exist outside the body for a month. Experiments, so far, have dealt with the amoeba in connection with sand and water. There is nothing before the practical sanitarian to show what, if any, connection there is between dysentery prevalence

and contaminated clothing. As an impression gained from many years sanitary inspection of numerous large jails, in addition to the long recognized agency of flies, partly desiccated blown particles and water, it has suggested itself to the writer that spread of dysentery may be connected with contaminated clothing, more especially blankets. Of course, careful management of a jail implies that no used clothing goes back to store for re-issue to new admissions, unless cleansed and disinfected, but with hard worked subordinates and quickly fluctuating strength of jails, there are at times lax interpretations of both terms. Store-rooms are not always flooded with light nor, in the rainy season, free of damp. Practical experience has dictated to the writer that routine disinfection of all clothing previous to storing, for re-issue, has a decided beneficial effect on jail populations suffering from dysentery. This is a mere empirical deduction, and one which cannot be freed of the protective influence of other preventive measures; but, in the face of the now stated vitality of *E. histolytica* cysts, it is well worth the few experiments that would settle the suspicion.

Typhoid.

Disinfection of Typhoid Stools.

Dr. Hutson, Public Health Inspector, Barbados,* calls for special attention to the following method of dealing with typhoid stools. He states its efficacy has been verified "by the bacteriologist of the Massachussetts Board of Health and found to be efficient."

"It was found that the addition of about a cupful of commercial unslaked lime to a typhoid stool will generate enough heat to kill the typhoid organism. Cold water may often suffice, but it cannot be depended on owing to the varying quality of the lime. Hot water from 50° to 60° C. will always give the desired results. The lime used should be broken up in small pieces and distributed over the stool."

Cholera.

Cholera in Burma.

The curative branch of medicine has done much to rob cholera of its former death dealing rate, in the presence of Sir Leonard Rogers' hypertonic saline intravenous treatment. The "*Statesman*" (Calcutta) reports (July 27th) that the recoveries from attacks of cholera in Mandalay under this method have been 67 per cent. The efficiency of this treatment, as now pursued, is an earnest of the benefits of modern research under Sir Leonard Rogers' guidance. The idea was, however grasped many years back, although the methods adopted were crude. Vol. 1, January 1839, of the *Madras Quarterly Medical Journal* contains a paper by Dr. John Murray, Dy. Inspector, in which he recommended the use of saline enemata in place of intravenous injection; and he adds that previous to this method being adopted, it was usual to "inject saline solution into the veins, from its having been discovered by chemical tests that the serum of blood in cholera patients is deprived of some of its natural saline ingredients, and the operation was certainly attended with astonishingly restorative effects, but situated as we generally are in this country [India] this plan is impracticable."

*Barbados. Second Annual Report. 1914. p. 17.

"Pneumococcal Infection in Jails" (?).

A matter of great interest in connection with the health of the prisoners in Sierra Leone is thus referred to by Dr. Burrows* :—

"*Cardiac Disease in the Prison* [Freetown] also gave rise to special investigation. It was clearly demonstrated that some obscure affection of the heart supervened among prisoners who had been admitted without any obvious signs of disease. Referring to old records of the Medical Department of this Colony I find that in 1873 heart disease among prisoners assumed proportions necessitating an investigation by the Colonial-Surgeon at the request of the Governor-in-Chief. It was presumably an affection of an infective nature for five deaths supervened among seventeen cases between November 28th and December 12th. Unfortunately, no details seem to have been recorded of the symptoms. Dr. McConaghy has now advanced a theory which is ingenious and which will be more thoroughly investigated when conditions permit the Medical Staff to resume normal duties. Recently a Medical Authority reporting on certain jails in Burma has given it as his opinion that pneumonia is endemic in certain prisons. This Report, received after Dr. McConaghy's was made, serves to strengthen his theory of pneumococcal infection producing endocarditis, etc. (vide Section IV. 'Scientific.')."

The writer suggests that were it not that the Medical Officer in charge of the jail reports that three deaths occurred from myocarditis and one from endocarditis (no post-mortem results however being stated) it would have been desirable, in regard to less evident cases exhibiting cardiac symptoms, to have eliminated suspected past or present beriberi subjects—in the case of a jail where this disease was present to the extent of 32 hospital admissions with four deaths, in 1913.

Beriberi and Scurvy.

The following remarks by Dr. Darling recorded in the *Proceedings of Medical Association of the Isthmian Canal Zone* (April to October, 1914, p. 92) are of interest, in regard to the group of food deficiency diseases :—

"Funk mentions five groups of symptoms observed in diseases caused by food theoretically deficient in 'vitamines' :—

"1. Nerve degeneration with paralysis and contractures.

"2. Cardiac : Dilatation of right heart, dyspnoea, cyanosis, oliguria.

"3. Anasarca, hydropericardium, hydrothorax, ascites.

"4. Scorbutus with mouth lesions, skin, subperiosteal haemorrhages, and bone lesions.

"5. Pellagra syndrome : Stomatitis, gastrointestinal lesions, skin erythema, and multiple-nerve symptoms."

"While Funk may be right about the etiology of groups 1, 2, 3 and 4, it would seem to be unwise to include pellagra in this group, for among other reasons, while pellagra is a disease 'occurring in maize-eating countries par excellence,' the eating of overcooked, undercooked, and overmilled, kiln-dried maize in large quantities takes place among negro labourers and natives in South Africa to an enormous extent, for it is frequently their sole article of diet. Yet pellagra is practically unknown among that class—*they do, however, suffer from scurvy.*"

Alluding then to the cardiac hypertrophy and dilatation, long recognized as found in beriberi and the Rand type of scurvy, he proceeds to show the alliance of the two diseases by comparison of the clinical symptoms, as judged by cases seen by him in the Rand :—"In addition

* Medical Report on the Health and Sanitary Condition of the Colony and Protectorate of Sierra Leone for the year 1915.

to these, this lesion is constantly found in beriberi and the Rand type of scurvy. It is the type known as eccentric hypertrophy or hypertrophy and dilatation characterized by thickening of the muscle and an increase in the size of the cavity. It seems to be due to a gradual strain on the right ventricle from loss of vagus innervation." This clinical picture is followed by an allusion to a statement by COUVY (*Annales d'Hygiène et de Médecine Coloniales*, 1911, No. 1, p. 97) who

" gives an interesting account of an outbreak of beriberi and of scurvy in a garrison of soldiers at Akjoucht (Mauritania, May to September, 1908). There were 150 natives and 11 Europeans. Beriberi appeared first among the natives, later cases of scurvy appeared among them. The officers, however, during the same period, had only scurvy with no symptoms of beriberi. . . .

" Among those suffering from beriberi, as well as scurvy, the suppression of rice from their diet and its replacement by other articles, was followed by the disappearance of cardiac troubles, asphyxia, pulmonary edema, and subcutaneous edema, but had no effect on the classical lesions of scurvy : Spongy gums, muscular pain, and induration of limbs.

" This very instructing observation of Couvy illustrates the personal racial or idiosyncratic factor of this group of diseases, for as far as can be ascertained, following the use of meat with one other article of food (polished rice), and associated with excessive consumption of salt (saline spring water), two distinct syndromes appeared among the men who were getting the same ration (native soldiers)."

During the discussion which followed Dr. Darling's paper, Major ASHBURN brought forward evidence to show that " classical scurvy is clinically, pathologically and etiologically different from beriberi," and added that there may be " other deprivation diseases, due to the lack of unknown vitamines that produce diseases resembling both, and that the two diseases may coexist in the same individual in varying degrees of severity, and so account for a whole gamut of clinical symptoms that seem to connect the two and make them appear like clinical variations of a common disease."

Finally, Dr. Darling, at the end of the discussion, took care to emphasize his position as follows :—" What I had hoped to bring out was that the two points of contact in these widely different diseases, namely, right-sided cardiac hypertrophy with degeneration, and degeneration of the vagus pointed to a somewhat similar acting cause—dietary deficiency."

The material brought to bear on the subject by Dr. Darling from his observations in the Rand is of much value, in supporting his main contention of the analogy between scurvy and one of the recognised forms of beriberi as food deficiency diseases. But the evidence appears to the writer to leave the subject at that point. There would seem as much evidence to term the food deficiency disease found in the Rand beriberi as scurvy.

The quotation of COUVY Dr. Darling affords would support the opinion that the two diseases, in the presence of diet deficiency, can prevail together or at different periods of neglect of specific food substances; thus, COUVY considered that " beriberi appeared first among the natives; later, cases of scurvy appeared among them." This would certainly tend to show that these two diseases can appear concurrently, and the chances are that the interval between the scurvy and beriberi emphasized the deficiency, in proportion to the grade of physiological requirements, of two distinct vitamines.

To such an argument, Dr. Darling replies as follows :—

"It may be urged by some that there is latent beriberi on the Rand and that many of the cases of scurvy overshadow the beriberic symptoms. This can definitely be ruled out, for in all the cases I examined with regard to this point the knee reflexes were exaggerated, *not absent*, as in beriberi, there was no anasarca, and no paralysis or extreme general atrophy as in beriberi. Besides, the pathological material examined was taken from cases which anatomically were uncomplicated scurvy."

This presumes that it is pathognomonic of beriberi that the reflexes should be absent. This however the writer would regard as an assumption founded upon observations of beriberi cases in a late stage. In the early stage, there may be exaggeration of the knee reflex.* If then this differention of the two diseases be not exact, there would be left in doubt, as to applicability, Dr. Darling's pathological observation, founded on post-mortems in the *Rand scurvy cases*, that there existed "right sided cardiac hypertrophy and dilatation and fatty degeneration of the vagus and its branches." The bulk of the evidence would go to show, as in Couvy's cases, that in the Rand not solely scurvy but beriberi with scurvy superadded was dealt with.

Helminth Infection.

Healthy Hosts of Parasites in Sierra Leone.

In Section IV of the Annual Report of the Medical Department of Sierra Leone, 1915, Dr. G. G. Butler from a careful study of 75 *apparently healthy boys* of the Bo School gathered much useful information.

Examination for malaria showed that 37·3 per cent. were infected, all except two being bearers of the sub-tertian parasite. He found that those of low average age had a higher rate of infection than those of a greater age. 50 per cent. of the boys showed "some enlargement of spleen."

Ankylostomiasis. In only one of the 75 boys absence of ankylostome ova was proved, and Dr. Butler considers that, seeing in 80 per cent. of the infected subjects ova were found in a single examination, infection must be held to be heavy. To this he adds the observation that these boys in no way exhibited any of the classical symptoms of ankylostomiasis and, supported by the fact that their school sports were fully as vigorous as those of a public school in England, there would seem no ground to suspect present inimical effects; although he suggests that, in the presence of debilitating influences, which might supervene in future, such results might well occur.

Filariasis. 9·3 per cent. of the boys were found to harbour microfilaria (all sheathed) apparently of the *nocturna* type.

Bilharziasis. Infection with malaria, filaria and ankylostomiasis, and yet for the subjects to be apparently in health is a fairly good record, but Dr. Butler had not thus exhausted possibilities. He found no less than 26·6 per cent. suffered from bilharziasis, yet, "the Annual Medical Report during the last ten years only mention five cases."

*This opinion is also expressed by Colonel W. H. Willcox, C.M.G., p. 191 of the *Jl. Roy. Army Med. Corps*, 1916. Aug. The writer in a Report to the Madras Government dated Oct. 1899, drew attention to this fact.

His attention to this subject was first arrested by examining a case of supposed gonorrhoea. He had previously found such cases to be really instances of urinary infection with Bilharzia, and that natives cannot differentiate between the two diseases, both of which are known in Mendi as "Kanye." They ,however, distinguish a white variety and a red, the latter pointing to bilharzia. In instances of infection, no cystitis was found, and Dr. Butler concludes that "it would appear therefore that urinary Bilharzia disease may eventually be present without causing any signs of cystitis whatever, and without giving any trouble to the host though in young children most severe signs of cystitis are usually present."

The importance of these observations in endeavours to prevent spread of the disease is obvious.

In regard to etiology, Dr. Butler states that the 19 boys found free of the disease came from a district where the streams dry up in the hot season (Timnee), whereas those infected came from a district (Konnoh) where streams are permanent.

Water.

Disinfection.

The presence of electric power is not confined, in the present day, to temperate zones, nor the necessity for disinfection. Hence, the following simple arrangements used by Mr. Dakin on the "Aquitania," as described in the *Times* of the 1st January, 1916, should be found useful in certain emergencies :—

"The apparatus consists of an electrolytic cell, a reversing switch capable of carrying 100 amperes, and some ordinary insulated electric cable. The cost is about £50. The cell stands upon a rubber mat to insulate it, and is raised upon a low table to enable its contents to be poured out easily. It is filled with cold sea water, and if a current of 60–75 amperes at a 110 volts be then turned on a solution containing two parts of sodium hypochlorite or available chlorine to 1,000 parts will be obtained in five minutes. The cost of this solution works out at 3d. per 100 gallons.

"This solution can be used, diluted with equal parts of sea water, for swabbing floors, latrines, infected areas, and decks, and acts as a powerful disinfectant and deodorizer. . . .

"The solution is also excellent as a sterilizer of drinking water (one part chlorine to one million parts), and as an antiseptic for wounds (used undiluted as produced by the electrolyser, i.e., two parts hypochlorite of soda to 1,000 parts). . . . It was added to the water in the swimming bath of the ship in the proportion of one part in two million parts, with the result that bacteria which had formerly been present in the water to the number of 2,000 per cc. were reduced to 200 per cc. or 90 per cent. . . .

"In the case of the Aquitania the economy in largely replacing expensive coal-tar disinfectants, such as carbolic acid, cresol, etc. by electrolytic hypochlorite will approximately pay for the cost of the cell (£50) in the course of a single trip of three weeks."

The electrolysis of sea-water for the production of sodium hypochlorite is of course not new, but Mr. Dakin's simple method of adaptation of the principle involved is of value.

The Efficiency of Public Water Filters.

The following extract from the Report on the working of the Microbiological Section of the King Institute of Preventive Medicine,

Guindy, Madras, for 1915, shows that the Director, Lt.-Col. Gibson, I.M.S., is energetically pressing forward work on the subject of water storage and purification, which must prove of vast utility in aiding practical sanitary advance in the tropics :—

"A very large number of samples were examined in connection with the experimental filters at Guindy, the Madras Corporation at Kilpauk, and proposed or extended water works in the mufassal. . . .

"An examination of a very large number of results of bacteriological examinations conducted during this and previous years leads to the conclusion that, in some way or other, sand filtration exercises a selective action on water bacteria, and that in general the lactose fermenters are much more completely eliminated than other kinds. In other words, and as compared to English results, the total counts are relatively high notwithstanding the fact of the lactose fermenters being satisfactorily decreased. As the lactose fermenters are the main indication of potentially dangerous pollution, this state of affairs is a highly satisfactory one. An explanation of this is probably to be found in the interesting discovery made by Assistant-Surgeon T. Sitapati Ayyar that a very large percentage, 98 per cent. in fact, of the total count in sand filtered water are spore-bearing or coccal forms. It may probably be inferred from this that spore-bearing forms succeed in penetrating the filtering skin while in the comparatively small spore state, and that efficient sand filtration does as a matter of fact completely eliminate all bacillary forms. Should this find be confirmed by further investigation with Madras and other Indian waters it will be one of first class importance, since the organisms of all waterborne-disease are bacilli."

Food.

The Corrosion of Metals.

The question of corrosion of metals is one to which the engineer gives special attention in regard to strength of material, but in regard to food preparation and preservation, sewerage and water supply, the subject is also of interest to the sanitarian. The following extracts may therefore be of utility :—

"The results of the investigation into the corrosion of metals indicate very clearly that cast brass, sheet brass, copper, and lead are corroded by dilute solutions of bleaching powder, acetic, nitric, and hydrochloric acids. These acids and bleaching powder are used extensively in the hospital and eventually find their way into the waste pipes of plumbing fixtures. The corrosion was more marked when the metals were only partially submerged, and also when they were submerged intermittently with intervening opportunities for drying. Under these conditions, the metal showing the most pronounced degree of corrosion was lead."*

Aluminium.—In 1896, the Imperial German Health Bureau stated :—

"Aluminium is entirely free from communicating to food any poisonous salt such as is given off by copper, tin, or lead. To make sure that no injurious effects need be feared if aluminium be taken into the system, two physicians, aged respectively twenty-six and thirty-five, volunteered to act as subjects. To each of these was administered daily, with their lunch, about fifteen grains of aluminium tartrate for a period of a month. By the end of that time neither had lost flesh or appetite, nor felt the slightest discomfort. For cooking purposes this metal seems to be peculiarly adapted, as it is a splendid conductor of heat, while it has also the advantage of being non-poisonous and non-corroding."

* Report of the Department of Health of the Panama Canal for the Month of April, 1916.

This positive opinion does not accord with that expressed by the U.S. Public Health Service Annual Report (Division of Pharmacology) which stated (p. 92, 1915) that :—

" Additional analyses of the ordinary foods for their content in soluble aluminium salts were made. It was found that almost all vegetable foods contain small quantities of aluminium. The continued administration of aluminium salts to animals leads to nephritis with the appearance of albumin in the urine. The question as to whether the quantities of aluminium salts consumed by man have any deleterious effect upon the body is still left open."

The following is quoted from the Transactions of the International Engineering Congress, 1915 (p. 569) :—

" Moist air rusts aluminium, not as quickly as it does iron or steel, but about as quickly as it does copper. An apparent exception to this statement is the white aluminium paint, which is weather-proof, but this is because the aluminium in it is ground up in presence of grease, which coats each particle and protects it from oxidation.

" The oxidation of polished aluminium takes the form of a thin white coating, quite continuous and adherent. It changes the color of the metal to a grey, and sometimes shows up spots like cigar ashes where the metal is not uniform in composition. Greasing or lacquering of the polished surface protects it well from oxidation, just as it would polished iron or copper. It can be re-polished by using bathbrick or sapolio, finishing off with silver polish (tripoli or electron) if a high polish is desired.

" Paint does not adhere well to polished aluminium, and if it is desired to protect with paint the surface should first be roughened or frosted, either by an acid wash or by sand-blasting. Oil paints adhere best. Aluminium surface can also be chemically blackened by a copper sulphide coating (gum metal or black-iron effect) giving a surface quite resistant to the weather, or to the effects of ordinary handling. This is frequently applied to sextants and surveyors' instruments.

" Only hydrochloric acid and caustic alkali solutions act strongly in the presence of salt. Soda solutions attack it and blacken it, they should be kept away from aluminium vessels. The highly seasoned curries of India are said to be hard on aluminium cooking utensils. The most severe combination it is likely to meet in ordinary cooking is strong vinegar and salt. Strongly acid tomato stew had some action on it, mostly in the direction of cleaning, for the utensil is brightened up inside by cooking tomatoes in it. On the whole, however, all common foods can be said to be without perceptible chemical action on aluminium, so that such cooking utensils are practically indestructible."

The writer suggests that it is probably not the " seasoning " of curries (if that term be confined to the various vegetable matters employed to render them hot to the palate) but the vegetable acid juices which are employed with them, which act on the aluminium. The verdict of " practically indestructible " depends very much upon the type of cook procurable for camping life !

Metal pipes.—According to " The Englishman " (Calcutta) of 15th June, 1916, clay soil affords protection to the exterior of pipes, provided it does not contain corrosive elements, " and if puddled close around the pipe only a few inches will seal the pipe from outside influences, corrosive or otherwise for an indefinite period. As a general rule clays do not contain ingredients conducive to corrosion." But owing to oxygen contained in porous sand and alluvial soil, there is, in the presence of damp, a corrosive influence ; especially " if they contain acids due to decaying vegetable matter." To neutralize this influence, the alkaline influence of lime may be employed " by surrounding the

pipe with lime or cement," or, before filling in the trench, pouring on the top of the pipes a thick solution of milk of lime. As to protecting the interior of pipes from corrosion the same paper* states that "experience has proved that a mixture of gas tar and oil in correct proportion" serves the purpose as well as in the case of mixtures containing, in addition, "a proportion of natural asphalt or constituents of it such as bitumen."

For protecting the gas tar and oil layer in the tropics when exposure to sun before laying is necessary, it is advised to protect it by a layer of lime washing.

*The Englishman, 22.6.16.

TREATMENT OF WASTE.

Filter Latrines.

In a previous number of this *Bulletin* [Sanitation Number, Vol. 4, No. 8, pp. 458 to 462] makeshift methods of using small aerobic filters as aids to sullage and sewage disposal are described, as introduced by the writer (W. G. King) in 1895 in the Madras Presidency. These were based on results secured up to that period by the Massachusetts State Board of Health. At the end of 1906, these ideas of adaptation were further expanded by his designing the filter trench and filter pit latrines described in the above reference. These contemplated the automatic separation of the urine and solid excreta, and the disposal of the urine, and ablution water if any, by soakage into the soil after filtration. It must be held in mind that this soakage into the soil after filtration is a very different matter to the use of so-called "soakaway pits," which have been long employed in military camps. Presenting as the filling of such pits does many voids in the midst of possibly impervious material, it is likely a certain amount of purification of fluids containing organic matter does occur in these before disappearance of fluids in the soil, but the Massachusetts State Board of Health trusted to no fortuitous conditions; they worked out the efficiency of aerobic filters based on definite thickness of layers of sand and its character, and size of gravel employed. For example, at pp. 431–452 of their Report for 1897 will be found their results of filtration of urine on such filters.

A grant was made at the end of 1906 by the Burma Government for experiments with these latrines. These were conducted by Lt.-Col. B. Singh, who erected them so that they should be used by the known population of Jail Warders at the Central Jail, Insein. The result was successful. The writer's successor, as Sanitary Commissioner for Burma, Lt.-Col. C. E. Williams, has encouraged the use of these latrines, and as a result of his experience speaks well of their sanitary utility. He has further adapted the idea by excogitating a form he considers suitable for use in flooded towns, such as are common in the Delta of Burma. He also finds it possible to use a layer of dry earth over the latrine filters with satisfactory results as to odours. Seeing that there are localities where sand is by no means easily procured, the fact that Lt.-Col. Williams' experience of their working, in the presence of a superimposed layer of earth, shows that efficiency is still preserved, should tend to increase the sphere of utility of these filter trenches and filter pit latrines. He gives his experience on the subject in the Annual Sanitary Administration Report for Burma, 1915 (p. 17) :—

"The aerobic filter system of latrines is slowly making progress in official estimation, and is being adopted in a number of fresh centres and out stations. There still exists a prejudice against the system on the part of some officials and communities *who have had no experience of its working.* The Town Committee of Pyawbwè contemplate introducing the bucket system, although the funds of this town, only recently constituted a 'notified area,' must be very limited, and the aerobic-filter system offers great advantages as compared with the 'removable receptacle system' in the economy of both initial and current expenditure. But the economical character of the former system is not its main recommendation in my estimation. Were it even more costly than its rival, I would still urge its adoption on the ground of its greatly superior sanitary efficiency."

Excremental Pollution of Soil.

Local authorities, informed that in such and such an area of a town human faecal deposits are frequent, are liable to regard the assertion of the sanitarian as an exaggeration of facts. The walks of members of Municipal Bodies are not likely to be taken by choice in insanitary areas and, if duty does so dictate, it does not follow they feel particularly inquisitive as to unpleasant facts. Under these circumstances, a mode of securing concurrence as to necessity for action is to ascertain measurement of means of transport, distances to be traversed, and number of trips possible and how far this resultant is capable of dealing with the estimated excreta of the population dealt with per day. For this purpose, the sanitarian not "above his last" should not be content with a list of means of transport said to be available; a full parade of the collection and transport staff, together with mechanical means employed, is essential. The revelation as to defective plant and plant under repair, and animals absent on account of illness, and of want of organization to meet the ends in view (even if the means are complete) may be noteworthy, and sufficiently explain facts as to soil pollution, in spite of supposed existence of efficient means. If the amount of excreta left unremoved from the area is large, an impression of its bulk may be borne in upon those responsible by computing the size of a column of faecal matter in cubic feet.

In connection with the Rockefeller Ankylostomiasis Campaign, a sanitary survey (U.S. Public Health Service Annual Report, 1915, p. 17) as to chances of faecal pollution of soil has been carried out on the following system, which should form a useful alternative to the above more direct method of calculation :—

"In the sanitary survey to determine the degree of soil pollution in rural districts the State Boards have now accumulated the following statistics :—Of a total of 250,680 farm homes, scattered over 653 counties in eleven States, 125,584 homes (50 per cent.) had no privy of any description, so that a theoretical maximum of soil pollution was occurring around these homes.

"The details for all the homes are as follows :—

									Points.
1,360	homes	with	type	A	privies,	at	100	per cent. ..	136,000
842	,,	,,	,,	B	,,	,,	75	,, ..	63,150
965	,,	,,	,,	C	,,	,,	50	,, ..	48,250
8,247	,,	,,	,,	D	,,	,,	25	,, ..	206,175
113,682	,,	,,	,,	E	,,	,,	10	,, ..	1,136,830
125,580	,,	without	any	privy		,,	0	,, ..	0
250,680	,,	give	total	score	of	..	..	..	1,590,395

"Average privy index, 6·3 per cent.

"These figures (6·3 per cent.) show a slight improvement over the average (5·8 per cent.) for the 189,586 homes for which statistics had been accumulated up to the preceding report."

SANITARY WORKS.

Malaria and Drainage.

When Ross advised the oiling of pools as a means of getting rid of mosquitoes, there was exhibited in his Report to the Government of India no desire to supplant drainage which should get rid of the pools. It was urged solely as an adjunct, which was of special utility where the cost of drainage could not be met. This merit has been proved indisputedly in practice and, in the proving of it, there has been no absence of disputation.

Of the efficacy of drainage as an anti-malarial measure, there existed no doubt long before the mosquito had been inculpated. It sufficed to believe that to secure the production of malaria, there need but exist moisture in a soil in excess of requirements of vegetation, the presence of organic matter (by preference from decomposed vegetable material) and a certain grade of warmth. In later days, to this creed was added the belief that there was present in particular localities a malarial " germ " in the soil, which flourished, or was latent, in accordance with the grade of the favouring conditions. To lower the subsoil water of a water-logged soil, to bring the land under a high grade of agricultural cultivation, to get rid of pools by drainage and, as a last resort, to cover land with a constant sheet of water as a palliative, were recognized anti-malarial methods. The use of quinine as a prophylactic was also well recognized.

If the theories excogitated to fit the results of these anti-malaria measures were wrong, the facts on which the false theories were founded were indubitable. Nevertheless, in one important part of the tropics it has been thought necessary to make experiments on drainage in connection with malaria, not, for example, with the avowed object of ascertaining whether excessive soil moisture control could be secured by particular methods in a locality presenting special engineering difficulties, but with the idea that drainage as an anti-malarial measure was open to question in the new light of the mosquito theory. But, putting aside opinions of this extreme character, there will constantly be found amongst authorities in charge of funds in the tropics, the honest opinion that *drainage* can only be secured at a cost which is " prohibitive," and hence a *laissez faire* attitude is adopted. Indeed, the term is so satisfying to many consciences that to enter into the question of framing even approximate estimates seems supererogatory. An opinion so formed in any locality is liable to be transmitted without question from one temporary official to his fleeting successor, by means of " office files," for years on end.

The duty of the sanitarian, in the presence of such a dictum, is certainly to uphold the truisms that the oiling of pools affords valuable control of mosquito larvae, that screening favours protection of humans from the possible attention of adult females, and that quinine prophylaxis decreases possibilities of their transferring malarial parasites; yet, at the same time, to insist that the control of moisture (surplus to requirements of plant life) by relief of surface and subsoil water, by measures commonly embraced in the term " drainage," is *the radical remedy.*

It may, however, safely be assumed that those who doubt the efficiency of drainage as an anti-malarial measure when stript of financial impediments, real or fancied, are rare. Hence, it behoves the sanitarian to ascertain under which of the two catagories the doubts of the public authority concerned are to be classed, and to attempt conversion.

In undertaking this task, unless the sanitarian is prepared to suggest a scheme which does not ignore the fact that both palliative and radical measures may of necessity, at certain stages of progress, accompany each other, and to back his opinions *by at least an approximate estimate of cost*, the chances of securing conversion are small. If available (as a weaker alternative argument), an instance of anti-malarial measures under analogous conditions of soil, cost of labour and material might be of some utility, but there should be no doubt as to the analogy. For example, an unqualified reference to success on the Panama Canal works in using not one but all appropriate anti-malarial measures, is likely to bring the sanitarian abruptly in contact with one of the main props in argument of the *laissez faire* policy, namely, the popular (and erroneous) conception of the cost of anti-malarial measures in that connection. The data secured by that splendid example of sanitary work have been misapplied, owing to absence of sufficient knowledge of local financial methods, to opposition of similar efforts elsewhere.

But an argument driven thus far successfully by the sanitarian is still liable to fail in its purpose. The authority to hold the purse strings and a knowledge of what is meant by "drainage," of the character required in anti-malarial measures, may not go together. There is, of course, no trouble in the average member of a Local Board remembering there are such things as surface drains: but the conception is usually limited to functions fulfilled by these in towns, and this applied to requirements of drainage in rural areas (apart from houses and streets or suburbs) brings to the mind a series of crude notions as to their applicability. Consequently, whilst the concession may be made that the adoption of drainage as an anti-malarial measure possibly may be financed in prosperous towns, it may be contended this is out of the question in the poorer rural areas.

When the sanitarian finds this view placed before him by an unrepentant public authority, the writer advises that the term "drainage" be dropped and, in lieu, thereafter be used the phrase "relief of surface and subsoil waters."

The term at least secures a clear conception of what the ends sought are, whilst leaving the means, which are not confined to "drainage," popularly so-called, a matter of selection as to cost, adaptability and efficiency.

Urban or Rural Areas First.

Those who would differentiate anti-malarial treatment according to the classification alluded to in the preceding note, ordinarily confine their opinions to the employment of surface drains, and the relative incomes of public bodies per head in rural and urban areas, respectively. They maintain that such money as may be available could better be devoted to the large populations of towns than to the more scattered populations of rural areas.

As to the relative cost argument, the chances are always that selected highly malarious villages containing an aggregate of, say, 20,000 inhabitants, could be made rid of malaria at less cost than feasible for a single highly malarious town of the same number of inhabitants. Without going into details on this point, it would suffice to show that, other things being equal, the relative cost of vested interests, land, labour and material, and, above all, the large area actually occupied by houses in urban areas, by limiting choice of engineering methods, is liable to turn the balance decidedly against the town areas. But, the truth is that to make any hard or fast line between urban and rural areas is absurd. Such distinction ignores the patent fact that the human being is the carrier of malaria, and that no locality producing such carriers is otherwise than a danger not only to his immediate neighbour *but to the country at large.* This being so points to the necessity of anti-malarial measures being regarded by local bodies in charge of large rural areas as meriting financial aid from central funds, where in the presence of decreased prosperity of the community owing to severe malaria incidence, local resources do not suffice; and, secondly, to the conclusion that anti-malarial measures should not be conducted on the principle that rural areas must wait till urban areas be remedied, but that the great malaria centres of a province should be deliberately selected in respect to their danger of producing carriers possessed of travelling facilities on important lines of traffic, and that *radical* anti-malarial measures should be applied accordingly, whether they be rural or urban. Equally, there can be no real differentiation of anti-malarial measures applicable.

As to cost being "prohibitive," the relation therefore is not between urban and rural areas but between mosquito-breeding areas, and the possibility of their being rendered unsuitable for breeding. All practical workers readily realize that, in the neighbourhood of malaria stricken villages, the little dribble of clear subsoil water making its exit in surface pools, which for generations at certain seasons have furnished motherly mosquitoes their opportunity, and have been the headquarters for raids upon unsuspecting humans —whether in urban or rural areas—may often be dealt with at a cost which might be less than the capital *wasted* by the sickness of half a dozen inhabitants. Indeed, opportunities of dealing with trivial and localized causes of malaria propagation are so great in rural areas that to neglect them by reason of an ill-conceived differential classification of the nature discussed, is inimical to reasonable sanitary advance.

Preliminary Surveys for Relief of Subsoil and Surface Waters.

Lay authorities, hesitating as to expenditure on radical measures for relief of subsoil and surface waters, are usually confronted with a difficulty that may not be apparent to the sanitarian. They are asked to consider the circumstances of a locality already malarious, and to believe that surplus water conditions are at the root of the evil. They may well recall immense areas under irrigation, or other causes of excessive receipt of surface flow, which nevertheless are free of malaria. Hence, the sanitarian must be prepared to discuss the sanitary history and physiography of both the malaria stricken and malaria-free locality, in relation to facilities favouring propagation of special

anophelines. But, before it is possible for him to make proposals for a particular locality, it is necessary for him to have fulfilled a complete sanitary and anopheline survey of the area concerned. Now the "area concerned" is a point worth defining. According to one school of malariologists, before it is possible to treat the surroundings of an inhabited area, not only its immediate neighbourhood but a whole province of many thousand square miles may have to be examined. Yet the mosquito is autochthonous in its method of conveying disease; and if after a lapse of 18 years since Ross's discovery it is found that, according to the evidence quoted in the preceding note, *a mile zone implies reasonable safety and less distance a fair approach to it*, the question of the "area concerned" and the anti-malarial measures necessary within it should be capable of statement and of estimate.

It is obviously of no use to measure the zone as "within municipal lands," which may have a zig-zag boundary giving various measurements. If the zone selected be a mile, the radius of the circle must be from the outermost houses of the inhabited area to a point a mile distant, whether that be within or without the area of any particular public body. But if such arrangement cannot be effected, it is apparent from the evidence quoted in the proceeding note that, as the distance within the mile decreases the protection becomes less, till the minimum of 200 yards is reached; and that, consequently, it must be rarely that a useful, even if incomplete, grade of protection cannot be secured *in proportion to money expended*.

To decide the most advantageous area capable of treatment for funds at disposal, it certainly does not suffice for the sanitarian to forget that he is not an entomologist, and think his task accomplished by a classification of mosquitoes. He has to satisfy himself which water sites they owe their breeding capabilities to, and how best with economy these can be got rid of. For the purpose of the necessary survey, the following extract by the Sanitary Commissioner for the Government of Madras, in February 1905 (W. G. King) bringing several of the requirements to notice, may be quoted:—

"Having settled the various sites where anopheles larvae are to be found, the next question that presents itself is as to how far it is feasible to eradicate such pools, and, if not, how far it would be advisable to adopt palliative measures by the use of larvicides. To this end, it is necessary to study the whole configuration of the country for several miles round, firstly, with the object of ascertaining how far the configuration affects the surface or subsoil water supply and, secondly, in determining from what furthest point the flight of the adult mosquito might be anticipated . . .

"As to the configuration of the country affecting surface and subsoil water, necessarily, there can be no limit of the area which must be taken into consideration. A complete general knowledge of the trend of the country, of neighbouring hill ranges and of streams, must be secured by actual observation, and by means of maps. Nor when this much has been done should the observer rest satisfied. In a country where irrigation by artificial impounding of streams and surface waters is constantly effected, attention must be given to the influence of artificial canals having their levels above or below the surface soil, not to speak of the attendant huge areas of country laid under cultivation with the aid of irrigation. It would be impossible, in the limits of a Circular of this description, to enter into the many points which should constitute a sanitary survey of the nature requisite, but it may be said briefly that officers should hold in mind and systematically investigate the following points.

"What is the height of the subsoil water of the area? Is there great variation in one part as compared with another? If so, what is the cause of variation and what the nature of the obstruction? Is it due to the formation of any tank bund reaching to the first impermeable stratum of the subsoil in the direction of the outflow, or to constant soil saturation under irrigation at the natural point of exit of the subsoil water; to the introduction of a canal athwart the natural exit, or to the recent raising of the water level of a river or canal by means of bunds or permanent addition of volume of water; or, instead of being at the natural point of outflow of subsoil water, have such factors been introduced on the upper part of the trend of the country, and therefore of the probable subsoil water gradient. It will be noticed that any of these factors may imply the existence of pools and sluggish streams of water more or less permanent following obstruction to surface, and subsoil drainage, or raising of the subsoil water level; and that certain of these conditions might lead, in a country with a fair slope, to a condition of springs appearing at the surface, in such a manner as to produce that periodical renewal of clean water which is the delight of the anopheles. . . .

[Here followed local illustrations of conditions mentioned in relation to malaria production.]

"The above illustrations obviously afford room for the application of various methods such as, in the instance of a canal aligned above the general level of the country, cutting a catch water drain or subsoil water drain between it and an inhabited area, or of breaking the bunds of a tank including its puddle foundation, so as to permit the free exit of surface and subsoil water at the terminal end of a drainage line; the diverting of springs, so as to take a definite course, instead of permitting them to disperse themselves over large areas in the form of pools: the making of surface drains so as to connect pools and drain them to a favourable point for discharge: the cutting through banks of rivers that obstruct sub-streams from pursuing their original course: cutting into banks of rivers whose configuration has been changed parallel with their course, so as to secure a subsoil drainage system with the exits at a lower point of a river: the altering the outlet of channels and small streams and changing the shape of the bed and banks, so as to secure a velocity as nearly approaching three* feet per second as feasible, without allowing of nooks protected by vegetation so as to permit of calm spots, or effectually lining their banks for this purpose with smooth masonry: the introducing of water required for garden crops by means of covered pipes, instead of using open channels and cisterns, and seeing that the quantity is so regulated as to be absorbed fully and daily by the earth to which it is to be supplied: the filling in of excavations or natural hollows in which water is liable to accumulate, or the periodical baling of them out individually, or leading them all to a suitable point for discharge; or where such point cannot be secured, employment of lifting by simple machinery, such as picottah, wind or water-power, oil engine, etc. . . .

"In carrying out minor sanitary engineering schemes to meet the above ends, it may often result that estimates will show that the work required cannot be effected with the funds at disposal, if highly finished materials be employed. For example, if estimates for subsoil drains depend upon prices in Madras, *plus* transport up-country, it becomes hopeless to expect progress. But ordinary village potters† can easily turn these out at a very small price, if they be shown once what is required of them. Very often instead of the use of subsoil drains, by means of cheap labour easily procurable, rubble from neighbouring fields may be obtained, which thrown pell-mell into trenches make very good so-called 'Irish drains,' which perform their purpose perfectly well. Again, in rendering a drain sufficiently smooth to prevent lodgment of water, it is by no means necessary to go to the expense of cement plastered concrete or masonry. Rough (lime mortar)

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*My own observation would seem to show that even one foot per second suffices, but this requires confirmation.

†The "village potter," provided with a hand-worked pipe-making machine, and some supervision on first using this aid, is at once a cheap and expeditious agent.

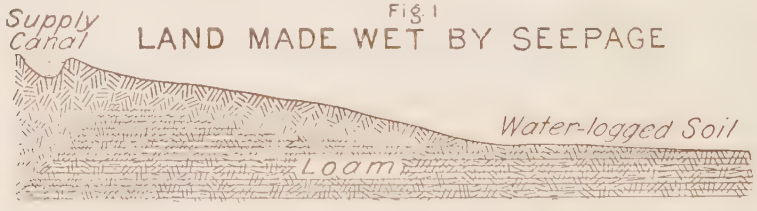
revetment with boulders although possibly diminishing velocity would at least secure the absence at the side of a stream of nooks, where the mosquito may deposit eggs with comfort to herself and safety to the future larvae. In studying economy in connection with channels of water where the use of a smooth lining and increase of velocity are requisite, it may often be found possible to considerably shorten the length of the stream by altering its course in accordance with the levels. In using kerosene oil, it should be remembered that the cheapest variety obtainable in the country may be safely employed. In filling up hollows near villages instead of carting earth from a distance, ruined houses and ruined walls will be found to afford plenty of material. Clearing such structures out of a village would be of benefit in respect to perflation. . . .

"In proceeding to conduct improvements after the 'endemic index' of the infected area has been definitely ascertained, it is desirable that the officer should traverse the whole tract of the country with his Overseer, and personally point out to him what is required. The Overseer should then prepare a survey plan of the area exhibiting its contours and levels. Upon this should ultimately be exhibited the various pools in which anopheles have been actually found. It will then be possible for the officer to consult with the Overseer as to the best points for discharge of surface water, or removing sources of obstruction, etc. After the plan and estimate have been fully prepared, the District Sanitary Officer should again visit the area, and come to a final determination as to the relative financial and sanitary value of various methods proposed for effecting the desired object. For such work, the new class of Sanitary Inspectors [Madras Presidency 1894] who have undergone Minor Sanitary Engineering training ought to be of great value."

Interception of Surface and Subsoil Water Flow.

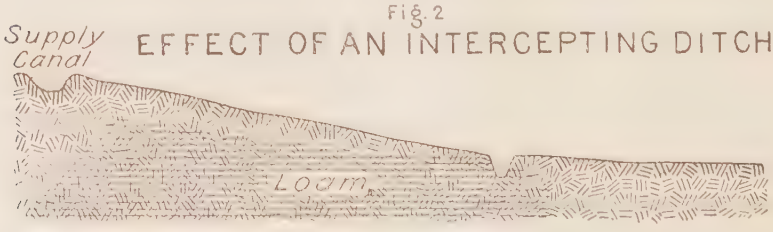
As to methods to be employed for the above purpose much useful information has been brought together in a paper entitled, "Drainage as a Corrective of Irrigation," by C. G. Elliott (International

Fig. 1



Engineering Congress, 1915, San Francisco). In this he urges the importance of the engineer undertaking a preliminary survey by borings to ascertain "the elevation of the surface and the water level and the position and character of the modifying factors beneath the surface,"

Fig. 2



so as to secure data regarding "the source, behaviour, and movement of the ground water which water-logs the tract of land. The drains

should then be located in accordance with the theory evoked. One principle simple in itself but not always easy to apply is to place the drain where the water enters and begins to accumulate on the saturated tract." In the light of the latter remark, the illustrations afforded by him showing methods of using intercepting drains (Figs. 1 and 2), which are here reproduced require no further explanation. Figs. 3 and 4 illustrate methods used where water under pressure cannot be

Fig 3
RELIEF WELL AND DITCH

intercepted " sufficiently deep to reach the underflow and cut off the pressure of supply. Under such conditions, the drains should be supplemented by relief wells which should be sunk well into this water-bearing material." Fig. 4 presupposes the existence of a suitable

Fig. 4
GRAVEL COLLECTING PIT
IN CONNECTION WITH TILEDRAIN

distant discharge point, and would apparently collect both the seepage water from the canal as well as the water from a stratum immediately below that under pressure.

In Fig. 5, he shows an amplification of the method depicted by Fig. 1, which should prove of frequent utility in anti-malaria work. The use of relief wells is by no means a new idea* but, so far as the writer knows, it has not been customary in British practice to employ them otherwise than at special sites on a work; but the method of using a chain of wells, as shown by Mr. Elliott, should prove both economical and useful on anti-malarial work. He does not, however, allude to what may be regarded as a reverse way of getting rid of subsoil water, namely, where an impervious layer supports water and overlays a pervious stratum, it may be possible, by piercing the impervious layer, to launch the water in a downward flow *in situ*.

*Mr. Elkington, in 1764, discovered the principle involved.

This might, for example, be accomplished when a gravel soil saturated with water rests upon an impervious layer of clay, beneath which is sand capable of accommodating an extra flow of water.

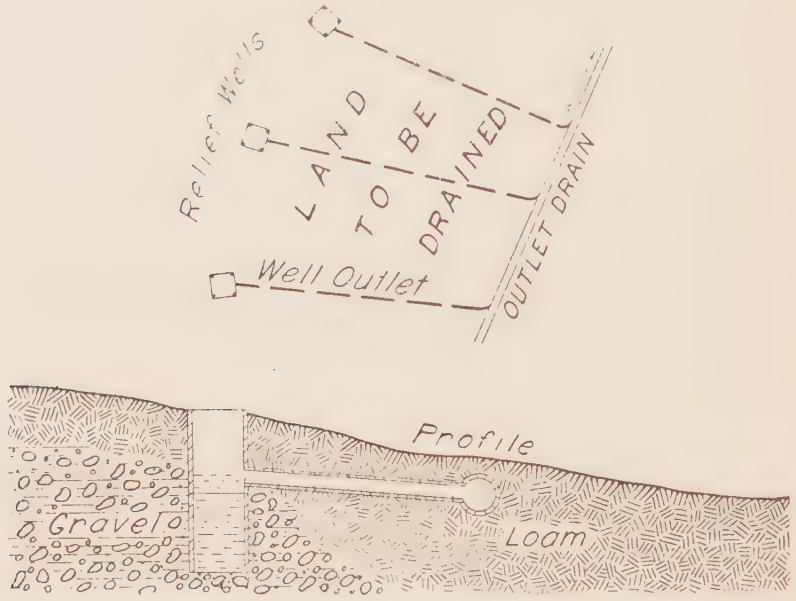


Fig. 5

DRAINAGE BY RELIEF WELLS

Relief of Surface Water.

The preceding note points to the fact that there must exist localities where the success of anti-malaria measures cannot be secured by attention solely to surface drainage. The value of surface drainage on systematic lines is indubitably great, and Malcolm Watson (himself an advocate of subsoil drainage) asserts that, in the irrigated plains of Malaya, he has secured freedom from malaria in the areas treated by this method. The sanitarian must be prepared by a study of the nature of soil and subsoil of a locality, as affected by meteorological and physiographical conditions, to advise generally as to particular modes for relief of subsoil water. Take, for instance, the discussion which has been spasmodically renewed since "the sixties" as to malaria in Bengal. In the area of older formation of the delta land which is most affected, the subsoil formation must be represented by a tangle of dead and dying rivers produced by changed courses of former river beds, here obstructing flow, there facilitating it.

To advance the opinion that in such areas surface drains alone would suffice (unless cut so undesirably deep as to act as mixed surface and subsoil drains), is impracticable; an obstructed point of subsoil water discharge, on receipt of an increment of subsoil water from a distant area, would bring about water-logging, in spite of calculated surface drainage discharge.

As a preliminary therefore to offering advice, a knowledge of subsoil conditions of the locality to be treated must be obtained. When the matter is simple a survey of wells, of railways and other cuttings, the general gradient of the country and of streams forming probable discharge points, may serve the end; but, in a tangle of conditions such as may exist in old alluvial formations, especially in countries subject to seasons of heavy rainfall, the procedure must be supplemented by systematic subsoil borings. In the opinion of the writer, this well recognised method would often be greatly aided by the employment of transportable pumping plant. A recognition of the rate of lowering of the subsoil water table and, at selected points, the direction from which the chief flow occurs (when checked by observation at distant borings) would go far towards aiding discussions as to the correct localisation of subsoil drainage in a 'tangle"' such as alluded to. This principle the writer suggests as applicable to conditions in Bengal taking *permanent* bheels (marshy lakes) as starting points of practical methods.

It may often occur that, in an area to which surface drainage would seem applicable, the sanitarian will be "held up" in progress, by the assertion that not till the whole has been subjected to a survey for "levels" can any work proceed. The remedy for this state of affairs was pointed out by the late Sir Edmund Buck, who maintained that valuable results could be secured by noting on maps of lands already surveyed for purposes of identifying ownership, the direction of natural flow of surface water. By steady application of this method, many useful schemes can be elaborated. In the United Provinces, these drainage maps have been employed successfully for many years (Agricultural Research Institute, Pusa 1915, Bulletin No. 53, p. 23).

But whilst concentrating the attention on the area to be treated, the sanitarian must never forget (whether the total land is small or large) that the selected point of discharge merits his careful inspection. The use of surface and subsoil drainage must affect the period of discharge, demanding consideration of breadth and gradient alike of a river or a mere ditch, and freedom from obstruction to flow from irregularities of contour or from old accumulations on silted beds.

The importance of so constructing surface drains, wherever funds will permit, that scouring shall not provide irregularities of contour of the side or beds and thus offer sites for mosquito breeding is obvious, and has lately been largely met by continuous concrete lining [see this *Bulletin*, Sanitation Number, 1916. June, Vol. 7, p. 440] or by the employment of re-enforced concrete in sections. To secure rapid and accurate work in excavating ditches, it is evident instead of trusting to hand labour the use of a machine would offer great advantages; land dredging machines have met requirements, but they are inapplicable to small surface drains. This is however no longer a difficulty, as, according to the *Engineering Record* (New York) 1916, July 29, p. 134,* there are now available oil engines working on the anchored cable principle, which can cut ditches, by means of a plough, 2 feet bottom width and 3½ feet deep. They have caterpillar wheels and, although weighing 15 tons "its large bearing surface enables it to travel over swampy land too soft to support a team."

*See also "Indian and Eastern Engineer" (Calcutta). 1916. July 29. p. 184.

Control of Subsoil Waters by Drainage.

In attempting to get a convert from the "prohibitive cost" theory alluded to (*supra*) the sanitarian will find, with the average lay member of local bodies, extraordinary ideas of the amount of subsoil water it would be desirable to remove to secure freedom from water-logging of the soil. It is well therefore to hasten to give the assurance that neither the shallow wells nor the success of agriculture need be interfered with, and that all that need be sought is that the maximum rise of subsoil water shall be *under control*—a result which is required both in in agricultural and anti-malaria interests. Frequently, the Engineer of such bodies may form a temporary adherent to the prohibitive cost theory and it is well the sanitarian should recognize that the profession so essential to sanitary advance has, as in the case of the medical profession, numerous branches. The engineer capable of designing and constructing a bridge, or reckoning strains in building material, may know little more as to subsoil water than that it is a nuisance to him when digging foundations in building operations, which has to be dealt with. Subsoil drainage properly so-called is regarded by the average engineer as a simple matter which concerns the farmer, and to him he is liable to leave its consideration. The sanitarian must therefore insist upon its importance, if he is to secure a professional coadjutor when a project is to be of large dimensions.

Should the area to be treated have much clay formation, any suggestion of subsoil drainage is apt to be put aside as unworthy of consideration. Such views however ignore the retentive capacity and its not insignificant capillarity and rest upon the unfounded opinion that clay represents an impermeable layer, and therefore can only be dealt with by surface drainage. Yet, were this correct, the farmers of the huge clay areas of Great Britain would hardly have sunk the enormous capital they have, which has resulted in improved agriculture and the disappearance of malaria. They have gone to this expense in the knowledge that, in the presence of subsoil drainage, the clay soil is rendered more permeable both to air and water. Indeed, were subsoil drainage unsuitable on clay soil, its employment in Panama to the extent of a million feet could hardly have been justified, when according to Le Prince "there is very little porous soil in the Isthmus, and a large part of the surface soil is of a clay-like character."

As to methods of subsoil drainage, the engineer who has delegated it to the farmer has done nothing to improve it for centuries. If Tomasi Crudeli be right, it is due to the use of subsoil drainage by the Romans that the surroundings of the City were kept free from malaria. It was the weapon with which the French effectually dealt with malaria in Algeria in the sixties; and although Gorgas and his staff took the sensible course of using all known anti-malarial measures, including the systematic use of oiling and surface drainage, it is to subsoil drainage that the chief value is ascribed. The following are quotations from "Sanitation in Panama," by Surgeon-General Gorgas :—

"Numerous open ditches interfered with the use of a horse-mower. [And the writer would add that in agriculture their use implies loss of arable land and difficulty in ploughing and in other agricultural operations]. To meet this difficulty, the inspector used subsoil tiled drainage wherever it was feasible. *This is the ideal anti-mosquito drainage* [italics not in the original]. It carries off the water, so that there is no formation of breeding

places on the surface. After it is once laid it requires no work or expense for up-keep, and a horse-mower can be used just as freely over its surface as if there were no ditch there."

On the subject of drainage generally, Gorgas in the same work (p. 201) states :—

"It is quite feasible everywhere, by proper drainage, to eliminate entirely the anopheles mosquito, and in several of our towns and villages we succeeded in doing this, and could have done it everywhere if it had been thought desirable by the authorities to apply the same methods, which had been successful at these places, and previously at Havana."

Le Prince, the Chief Sanitary Inspector, Isthmian Canal Commission, states :—"Without doubt, proper drainage is the all-important and most effective method of eliminating malaria."

It is satisfactory to know that the use of subsoil drainage is attracting attention in the Colonies. In the Annual Medical Report for Nyasaland 1914 (p. 21), the subject is thus expressed in reference to Zomba :—

"The recent extension of the existing storm-water drains should be of value as likely to reduce the number of probable anopheles breeding places, but it will be a mistake if the scheme is not carried to completion, with some method of subsoil drainage in the marshy areas that at present exist."

In the Annual Medical Report for Nigeria, 1914, p. 80, the importance of this method is also urged :—

"Subsoil drainage is not practised to any extent, useful though it has proved to be in the few places where it has been carried out, and we are convinced that with an extension of subsoil drainage a great deal of mosquito-breeding would be prevented and a large saving would accrue from the fact that much less disinfectant and kerosene would require to be used."

Control of Surface and Subsoil Waters by Pumping.

But whilst, where sufficient fall is at disposal to a reasonably near point, the above methods of discharge may suffice, it may well happen that the limits of property and absence of facilities for discharge by gravitation leave no choice but the use of pumping, and once more the verdict of finance may be "prohibitive cost." But, again, the sanitarian should require the local data upon which the verdict is founded, and not abandon possibilities till satisfied on the point.

There are conditions under which surface drainage and its subsequent maintenance might not be able to compete in cost with pumping. For example, the Irrawaddy has a habit, as a result of periodical floods, of raising huge banks which in certain places, on retirement of the river, shut off the stream from land by dykes which may have an elevation of 30 or more feet above the adjacent country. The river has a very small gradient to the sea, in the majority of its course, and to drain an area so as to discharge into the river may mean the extension of a surface drain for miles, before a point with sufficient "fall" can be secured. Tide-valves and the like with perforation of the bank in some cases might be applicable, but the choice must often be to pump, to raise a certain portion by "filling," by hydraulic dredger from the rivers or leave the water alone. The fact is that the popular dread of cost of pumping is founded upon the legend of steam engines of the type employed forty years ago. In the present day, the centrifugal pump driven by a good type of oil engine or electrical power has entirely altered conditions. Mr. Chatterton, M.I.C.E., has done much in

securing the employment of oil engines for irrigation in the Madras Presidency for raising subsoil water, and in the Bombay Presidency their use is daily increasing. In a paper on "The utilization by pumping for irrigation of underground sources of water supply" (International Engineering Congress, San Francisco, 1915) C. E. P. SMITH states :—"As an example of the excellent service given by these oil engines, a heavily loaded engine has run steadily through a 14 hour day without a visit from the attendant." He advocates combination of neighbouring farmers in pumping expenses.

In a preceding note, the writer has advocated the necessity for the sanitarian to survey the country for miles round, with the object of ascertaining from its configuration the factors influencing surface and subsoil flow. But he should also keep his eyes open *for streams capable of developing hydro-electric power*, which may enable him to secure for a population at once a water supply and its means of purification (ozone), cheap pumping for anti-malarial measures, and power for Municipal* and Commercial use. *All* these dreams might not be realizable, but, even if pumping power were secured, solid sanitary advance might be forthcoming and the cost *might* not be "prohibitive." Anyway, as a practical measure pumping to relieve the subsoil water, in reference to the injurious effect of water-logging in agriculture, and at the same time to economize it for use in irrigation, is now being attempted by the Government of India, under the advice of Mr. NETHERSOLE, C.S.I., the Inspector-General of Irrigation in India. In a paper entitled, "Recent Developments of Irrigation in India," presented at the International Engineering Congress, San Francisco, 1915, he gives a sketch of a system which is in an experimental stage. The combination of interests which these efforts represent is so important that its initiation, wherever electric power is procurable, should follow.

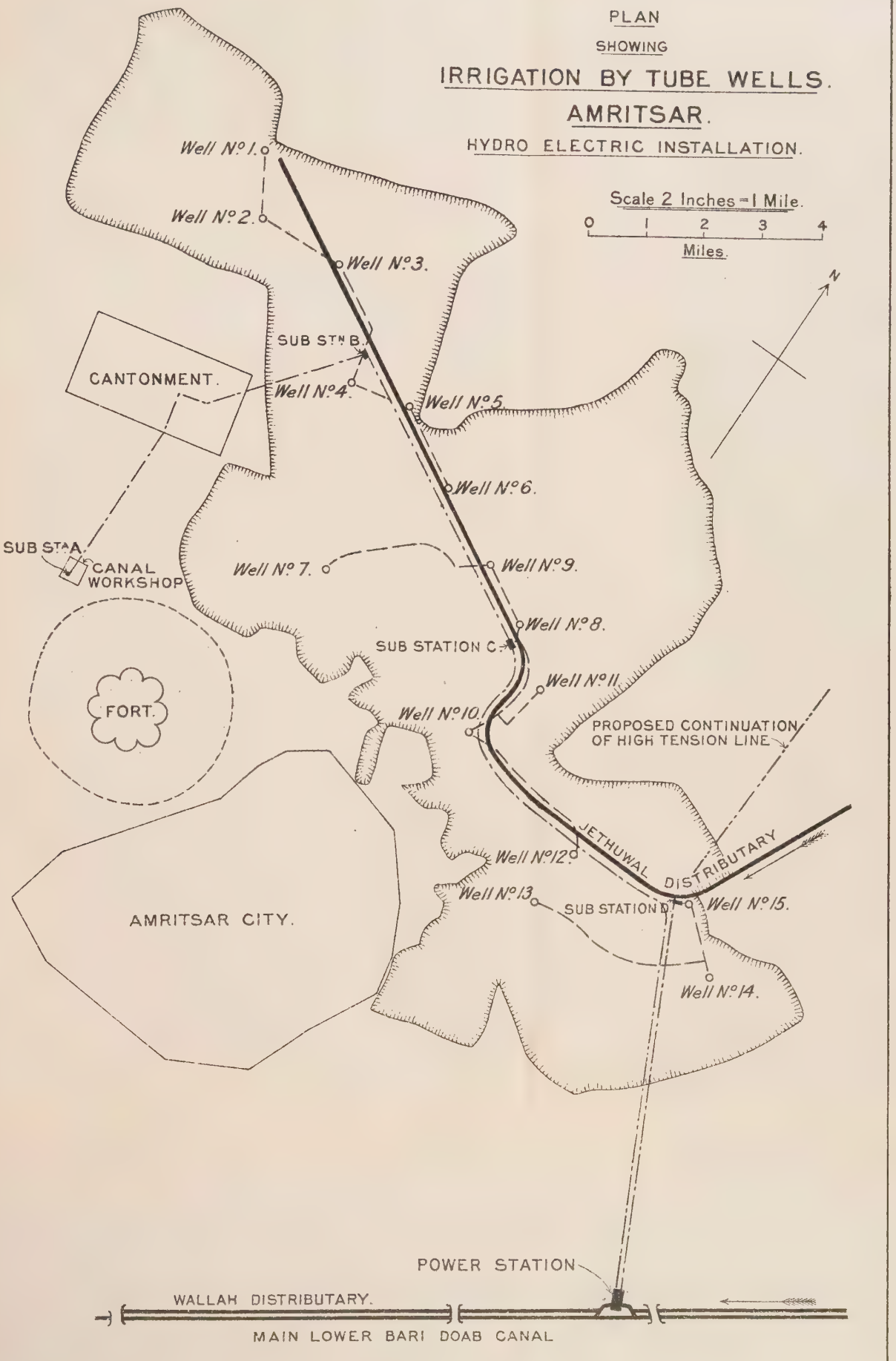
An extract from his description of the scheme, and a copy of the map which accompanied it is therefore reproduced :—

"This work which is now under construction may be referred to as the first serious attempt in this country to correct by pumping an undesirably high spring level in the soil due to excessive irrigation.

"Plate IV. shows the general scope of the scheme. The tract under treatment is in the immediate vicinity of the City of Amritsar, where, owing to the comparatively high value of the crops raised, cultivation is intense, with irrigation from the distributary of the Bari Doab Canal shown on the plan; consequently the subsoil water has gradually risen to within a few feet of the ground surface. Owing to the general low level of the tract as compared with the only available natural drainage outfall, it is not possible to attempt to lower the subsoil water-level by open or piped gravity drains, and the present scheme for reduction of the subsoil water-level by pumping is experimental in its present stage. Ample water power was available in the Main Bari Doab Canal where a masonry fall already exists at the site shown on the plan. The supply and fall sufficed for three turbines each of 270 hp., operating three-phase alternators each of 175 kilowatts.

"The power transmission line of 6,000 volts is shown on the plan; also the location of the 10 pumping stations now being installed, which have been chosen so as to conveniently discharge into the existing irrigation channels. By this arrangement existing irrigation rights will not be interfered with; the only difference being that the supply instead of being derived, as heretofore, from the Bari Doab Canal, thereby aggravating the high spring level, will be pumped from the subsoil water, thereby reducing it.

* It would indirectly afford power in a scheme such as outlined in this *Bulletin* (Sanitation Number). Vol. 6. p. 281, 1915. Sept. 15.



REFERENCES.

Line, 6600 volt 3 phase. ——— Existing water courses.

Line, 550 volt 3 phase. ——— First area to be irrigated by tube wells.

5658. W 2178. 20. 1850. 10. 16. Malby & Sons. Lith

"As the subsoil is of very fine sand, the supply will be obtained from tube wells sunk from 100 to 120 feet from ground surface. The tubes of 10 inch diameter are constructed of special copper wire of triangular section wound closely round a skeleton frame-work of steel rings and bars. The pumps are centrifugal, working on a vertical spindle at the bottom of the supply pipe, which, with the pump, is lowered into the well tube after that has been sunk; and each pump is to be worked by a 12 hp. three-phase motor. Experiments carried out during the past three years show that such a pump and tube well will yield a continuous supply of 2 cubic feet per second without clogging the tube well by drawing in the sand."

Preliminary Municipal Engineering at Panama.

In Part 1 of "The Panama Canal" by General Goethals, H. W. Durham, as "the formerly Resident Engineer in charge of Municipal Engineering at Panama," contributes a paper on the above subject. The conditions he was called upon to remedy were such as might be expected in dealing with old towns in any tropical area, where the *fiat* has suddenly gone forth that *radical* improvements are to be effected. The paper is therefore of interest from the sanitary point of view, with regard to the selection of methods and materials, in order of precedence as to sanitary requirements, under conditions that implied, at times, that one or other should be "makeshift."

The main and worthy intention of the paper, however, is obviously to put on record the work of men who laboured through the difficulties of the pioneer stage of Panama Canal construction, but who, their work accomplished, are apt to be forgotten. This, at first sight, would seem to be peculiarly the fate of pioneer workers in the tropics. The majority sacrifice themselves at the altar of duty, unheard of and unsung. To men thus infatuate the certainty that they are but atoms in the ever changing conditions of life, matters little. Still, Mr. Durham performs a graceful act in asking, in the following sentences, the survivors of a great sanitary and engineering victory to remember those who have fallen in the struggle :—

"Those on the Isthmus for this period lived and worked in conditions very different from any prevalent since then, or described in accounts of canal work. Comfortable screened houses with furniture, plumbing and electric lights; commissaries, supplied with cold storage; communication between settlements by good roads, club houses, excursion trains, sanitarians and other luxuries which have made the Panama towns the wonder of the swarms of tourists that have visited the zone in perfect safety and comfort;—these could only come after the labours of the advance guard who worked between and during malarial fever attacks, who saw companions daily carried to the hospital, and kept note of the increasing rows of white crosses in the burial ground and of the piles of pine coffins turned out by the carpenter shop as a side line to keep ahead of the demand, while their wives were living in rooms unscreened because requisitions were delayed, and meanwhile checking American funerals as they passed by, noting the flag-draped coffins."

But the Anglo-Saxon blood of the American in the Panama recognised no downheartedness, and Mr. Durham records that, notwithstanding the havoc of sickness and death, *esprit de corps* was so high, in branches of the Municipal Engineering Department, that "rival groups would race to working sites with the object of prompt fulfilment of work." Specification for materials suitable for the tropics "and following the usual methods extant" were forwarded to the purchasing agents

Washington. These were required "for the quick settlement of the water famine problem for the ensuing year, but serious delays were caused by academic debates on the part of certain authorities as to whether Pacific Coast specifications were inferior to those of New England." To meet urgent difficulties as to labour men were imported —for whom food and quarters were necessary—but "the Paymaster Department absolutely refused to make any advance until wages had been earned." The equipment of the Sanitary Engineering Department for Panama City consisted of teams, wagons, scrapers, ploughs, road rollers, etc. Indents were however not synonymous with supplies. In illustration of difficulties of central management, he records "after a long wait," the arrival of two rollers. "They presented a handsome appearance with fresh gold lettering," showing the name of a certain Company. Only locomotive engineers "discharged from the local railway for undue thirstiness were available to run them." Within a few days however

"the large gear wheel on one roller broke in two, displacing a section of rust on the interior face of the break, which had been covered with putty and paint. Shortly after, the link block on the other cracked and, when removed, showed, under its coating of metal paint, an unmistakable hardwood surface. As the new paint began to wear off the covers, other names developed beneath it, which led to a belief that both machines were reconstructed traction engines."

"Materials were seldom promptly available to complete work as planned. Division heads were frequently hampered by office methods designed for conditions nearer home. As an instance, it was necessary for a long time that each division have its own stores, to avoid their exhaustion by others, and the spectacle was presented of the Municipal Engineering carpenters spiking together 3- by 12-inch planks to make 12- by 12-inch posts, while less than half a mile away the saw mill of the building department was ripping 12- by 12-inch timbers into 3- by 12-inch stuff."

Water Supply.—The local authorities of Panama City had decided to secure a water supply from the Juan Diaz River, distant ten miles. Local vested interest supported this scheme. This would have given a constant supply, but at a prohibitive cost. Meanwhile, the abolition of receptacles for storage of water, or incidentally so acting, was urgently pressed by the sanitarians of the Canal Department, in respect to suppression of yellow fever and malaria. It was found that the French had made a dam in the neighbourhood of Culebra on the small stream called the Rio Grande, from which the water supply of neighbouring encampments had been arranged. The decision to use this source was arrived at, "because, while the latter [Juan Diaz source] was situated at a distance of ten miles from the Canal line, the Rio Grande supply was not only within the Canal Zone but immediately adjacent to the line of the Canal near its highest point, and could be used to furnish water, not only for Panama City proper, but for all towns on the southern slope of the divide, or nearly one-third the Canal route."

As the next step, it was ascertained from the Sanitary Department that this source was from a bacteriological and chemical point of view "an entirely proper source of supply." It is not however said that this opinion included the results of a sanitary survey of the source, nor that such survey was undertaken as a preliminary to any decision as to selection of a source, as should undoubtedly be the rule, but it is

presumable this essential point was not neglected.* The final plan, as approved, showed that at Rio Grande, there should be a storage reservoir served by a 16-inch pipe extending to Ancon, where the service reservoir to contain 1,000,000 [U.S.] gallons was to be located. This reservoir was divided by a central wall into two parts. From this latter point, the distribution system to the Panama City was laid down. No filtration was held to be necessary in 1904, but according to Mr. WELLS [vide foot note] by 1906 filters of the "Continental Jewel" type were installed, on additions of water from other sources being found requisite.

Pipes were not forthcoming with the necessary quickness, and the Engineer adapted "main galvanized rivetted wrought-iron pipes of 20-inch diameter which had been intended by the French for use with hydraulic dredges. The pipe in sections of 16 feet has flanged ends. Connection was made by bolting the flange through rubber gaskets to ensure tightness, and, as a precaution against drainage, the pipe was laid surrounded with 6-inch concrete." This was certainly a makeshift pipe, and it would be interesting to ascertain how far it has stood the test of time. In crossing valleys either bridge abutments or trestles were used for supports. Nothing is said as to use of air, break pressure or scouring valves.

It is noteworthy that as fast as the houses were connected with the service water system and sewers, the Sanitary Department "required the filling up of wells and cisterns and the removal of water containers."

Sewerage.—It was resolved to carry out the sewerage and water-supply distribution simultaneously. Irrespective of any sanitary advantage thus secured, this was regarded as a matter of convenience in respect to minimized disturbance of roads and water pipes.

It was determined to employ direct discharge to the sea for disposal. The tidal rise is from 14 to 20 ft. The City is surrounded by an ancient wall and, outside this, the beach was rocky in some places and sandy in others, "over which the water extended for a distance varying from a few hundred feet to half a mile." This dictated the advisability of not trusting to a single large and impervious main sewer for discharge.

"It was seen that, while no nuisance would be occasioned to the city by the discharge of sewage into the bay with its strong tidal currents, it would be necessary to place the outlets at low water mark to avoid any pollution of the beaches, and it therefore became requisite to find suitable points for outfalls, the location being governed, both by the drainage area to be served, and the possibilities of constructing an outfall sewer in a permanent manner, across the strip of territory exposed at low water. Inspection of the map, and of physical conditions at low water mark, showed three points where high and low water marks were reasonably near together, while the shape of the city rendered its division into three drainage areas most suitable. . . . These points being decided upon, and a line of intercepting sewers reaching to each outfall being laid out at the maximum available grade, the remaining task consisted of planning a series of sewers in the three districts named, which would reach these intercepters with a minimum size and quantity of pipe."

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*[In a paper by G. M. WELLS on "Municipal Engineering and Water-Supply," also included in Part 1 of "The Panama Canal," it is stated, "The Rio Grande watershed was uninhabited and was made a reservoir, so that the possibility of contamination was eliminated."]

The discharge calculated for was 60 gals. per head, an amount which, even allowing for the difference of the U.S. gallon is, in European ideas of water use and abuse, large. This having been arrived at, there remained the question as to what, if any, storm water was to be received. It was decided to accept " an estimated run off over the entire area of 2 inches per hour, with the exception of those streets within one block of the sea wall where all waters would be allowed to run off on the surface."

Local knowledge must be allowed largely for in evaluating the conclusions arrived at for selecting a combined system. It may be granted that a combined system in a country subject to heavy tropical rainfall would not, in the present day, be lightly elected. Leaving out of question the maxima rainfalls, the Ancon register (p. 238 " The Panama Canal ") shows that in the 33 years of which there are records, for the first quarter of the year, the rainfall did not amount to a total of one inch in the months of January and February on 12 occasions and, in March, on 11 occasions; so that for the majority of days during the first quarter of the year the sewers were of a size far beyond requirements. In view of this disadvantage and the admitted probability of " backing up " of domestic drains, the deciding factor seems to have been that since the " combined system was very much less expensive than a separate system and the narrow streets made it inexpedient to lay duplicate lines of pipe, this plan was thought to be more desirable from all points of view, and subsequent experience justified it."*

If, in absence of local knowledge, it is legitimate to use only the evidence afforded by Mr. Durham, the writer thinks that too much stress was probably placed upon the two items in the argument, (*a*) the expense, and the supposed necessity of (*b*), duplicating mains throughout in the narrow streets. It does not follow that in dealing with tropical rainfall a separate system need be more expensive than a combined system, nor that duplication of mains for a separate system need occur solely in narrow streets. Having, as in this case, at least three points of discharge at disposal, the chances always are that a selection of points of collection of surface drainage would have got rid of this undesirable method.†

Roads.—That there was reason to dread interfering at depths with the subsoil of narrow streets is, however, shown by the fact that while constructing one of the sewers " it was necessary to keep a gang at work continuously for two days in order to protect the sides, shore the adjacent buildings and prevent damage."

Nevertheless, at certain points,

" as labour was cheap and unskilled, it was decided to make sewer manholes of concrete, and, on account of the firm nature of the material excavated, a large number of these were constructed by digging a circular hole of the exact size of the manhole in advance of trenching, thus avoiding the necessity for exterior forms. While awaiting the arrival of supplies and subsequently on various occasions when these were inadequate several concrete sewers were constructed."

*It is probable this opinion is not fully accepted. Mr. Wells (p. 164 " The Panama Canal " by General Goethals ") states :—" In the city of Colon, a separate system was installed in the beginning, and in general has given better satisfaction than the combined systems in Panama and in the towns along the line of the Canal."

†At p. 184 of this *Bulletin*, No. 3, Vol. 5 (Sanitation Number, Feb. 28), 1915, the writer discusses certain methods of meeting difficulties.

The streets were paved with materials selected in accordance with their importance and nature of traffic. For the chief streets vitrified brick was laid, supported on a one inch sand cushion upon five inches concrete. In minor streets, 5-inch concrete roadway with a smooth surface were constructed without a layer of bricks. Where bricks were laid, cement gravel was employed with satisfactory results. Much of the brick received for paving was in a broken condition. This was used by "mixing both broken stone for formation concrete."

This would seem an incompatible mixture. The engineer in India would probably have utilized the broken brick for making *soorkhi* (puzzolama), which with hydraulic lime is no mean substitute for cement.

"The paving of the city was continued throughout 1906, being finished early in the following year, and amounted to a total of 65,000 square yards of brick pavement with a total length of 5½ miles, about two-thirds of this on concrete foundation and the remainder on macadam. There was also laid about 19,000 square yards of concrete pavement, having a total length of two miles. Concrete curbs were built on all streets."

Reinforced Concrete.

For wells.—In this *Bulletin* [Sanitation Number, Vol. 5, No. 3, p. 188] "pot" wells as used by the prople of India (that is, wells lined with earthenware rings) were described. Their prototype is found in the glazed stoneware well rings sold by manufacturers. In his paper on the "Utilization by pumping for irrigation, of underground sources of water supply,"* G. E. P. Smith refers to the use of rings of reinforced concrete for the lining of wells. It is evident that in many parts of the tropics the method would be peculiarly convenient in reference to transport difficulties. It would be an unusual locality which could not furnish men capable of digging within the ring of a descending curb. The matter would resolve itself into transport of bags of cement and iron material for reinforcement, and the provision for supervision of at least one man skilled in dealing with concrete and well sinking.

For houses.—At the last Engineering Conference in Rangoon† Mr. G. Clarke, Executive Engineer, D.P.W., read a paper on reinforced concrete, showing a mode of utilizing this material which the writer thinks should be useful not only as an economy for wood, as shown to be the case in Burma, but for semi-permanent houses and hospitals generally. Mr. Clarke is reported to have stated :—

"In Burma, houses with timber frame-work filled in with brick nogging have been the rule rather than the exception. In the past, in a Province where wood is of such good quality and used to be cheap, this form of construction was eminently suited to the conditions. Timber has now, however, greatly risen in price, and it has been found no longer possible to provide adequate accommodation in all instances at a cost within the limits prescribed. In this instance the usual timber posts, girders, wall plates, and quarterings were replaced by reinforced concrete with excellent results."

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* Paper read before the International Engineering Congress, San Francisco, 1915.

† Indian Engineering, 1916. May 27.

LANDS AND BUILDINGS.

Occupation of New Sites.

It is not often that it falls to the sanitary authorities in Europe to make plans for a hitherto unoccupied site. Their labours are chiefly concerned in acquiring portions of land and old buildings which, in the aggregate, suffice for effecting improvements. This must remain the rôle in dealing with older countries of the tropics, but as commerce advances extensions of old towns, or assumption of new sites, must follow. But, in the more recently acquired British possessions, the construction of railways and means of traffic on waterways must often give the opportunity of dealing with new sites. Few public bodies, however, yet realize the importance of all sanitary details as to occupation of a new site being thoroughly "worked out" prior to occupation. To stake a place out for roads and allot house sites for purchasers, and perhaps to dictate as to the class of house allowable within certain areas, has in the past often been the sum of effort. As to water supply, possibilities may have been ascertained but both this, conservancy, drainage and sewerage are matters which at times strike public bodies bent on economy as capable of attention, when the numbers of inhabited houses justifies the expenditure, In the absence of rulings to the contrary the expiry of six months may find, by purchase and transfer of plots of land, all hopes of planning *in the interests of sanitation* gone. According to the Annual Medical and Sanitary Report for New South Wales for 1913* it has been ruled that no owner of land may proceed to erect a building upon it without giving due notice of his intention; moreover all places of intended building must be vised by the Medical Offices of Health of the area concerned.

*New South Wales, Report of the Director General of Public Health, 1913. pp. 9 & 16.

Reprints and Pamphlets received:—

BALFOUR (Andrew). The Medical Entomology of Salonica. An Address delivered to the Salonica Medical Society May 17, 1916.—25 pp. With 31 text-figs. 1916. London: The Wellcome Bureau of Scientific Research.

BALFOUR (A.). Fly-Traps for Camps, Hospital Precincts and Trench Areas.—*Jl. Roy. Army Med. Corps.*, 1916.

BRUG (S. L.). Pigment und andere Einschlüsse in Dysenterieamöben.—*Arch. f. Schiffs- u. Trop.-Hyg.* 1916.

CARINI (A.) & MIGLIANO (L.). Sur un Toxoplasme du cobaye (*Toxoplasma caviae* n. sp.).—*Bull. Soc. Path. Exot.*, 1916.

CRAWLEY (H.). The Zoological Position of the Sarcosporidia.—*Proc. Acad. Nat. Sci., Philadelphia*, 1916.

CRAWLEY (H.). The Sexual Evolution of *Sarcocystis muris*.—*Proc. Acad. Nat. Sci. Philadelphia*, 1916.

FANTHAM (H. B.) & PORTER (A.). The Significance of Certain Natural Flagellates of Insects in the Evolution of Disease in Vertebrates.—*Jl. Parasit.*, 1916.

LOW (G. C.) & NEWHAM (H. B.). A Case of Ulcerating Granuloma successfully treated by Intravenous Injections of Antimony.—*Brit. Med. Jl.*, 1916.

de MELLO (F.), BORCAR (A.) & de SOUSA (L.). Contribution à l'étude des fièvres remittentes de l'Inde Portugaise.—*An. Sci. Facul. de Med. do Pôrto.*, 1916.

de MELLO (F.) & BRAZ DE SA (L. J.). A Contribution to the Study of Haemoprotozoa in Portuguese India.—*Indian Jl. Med. Res.*, 1916.

SWELLENGREBEL (N. H.). Over de Zoogenaamde "Intraglobulaire Conjugatie" van den Tropicaparasiet (Laverania Malariae).—*Nederl. Tijdschr. v. Geneesk*, 1916.

Note.—On direct application (not through agents or booksellers) any of the foregoing reprints or pamphlets will be sent on loan to any part of the world, the Bureau paying outward postage.

Books received.

DEADERICK (William H.) M.D. & THOMPSON (Lloyd) [M.D.]. The Endemic Diseases of the Southern States.—546 pp. Roy. 8vo. Illustrated. 1916. Philadelphia and London: W. B. Saunders Co. [Price not stated.]

HERMS (William B.) Medical and Veterinary Entomology. A Textbook for Use in Schools and Colleges as well as a Handbook for the Use of Physicians, Veterinarians and Public Health Officials.—xii+ 393 pp. 8vo. With 228 figs. 1915. New York: The Macmillan Co. [Price 17*s.* net.]

MAXWELL-LEFROY (H.) [M.A., F.Z.S.]. Measures for Avoidance and Extermination of Flies, Mosquitoes, Lice and Other Vermin.—2nd Edit. Revised for the Tropics. 17 pp. With 5 figs. 1916. London: W. Thacker & Co., Calcutta and Simla: Thacker, Spink & Co. [Price 1*s.* net.]

UNDERHILL (Frank P.) [Ph. D.] The Physiology of the Amino Acids.—169 pp. crown 8vo. With 1 plate and 13 figs. 1915. New Haven: Yale University Press. [Price 6*s.* net or $1.35.]

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